Technical Report 1301

Determinants of the Army Applicant Job Choice Decision and the Development of a Decision Support Tool for the Enlistment Incentive Review Board

Tirso E. Diaz, and Paul J. Sticha
Human Resources Research Organization

Paul Hogan
The Lewin Group

Pat Mackin
SAG Corporation

Peter Greenston
U.S. Army Research Institute

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Deputy Chief of Staff, G1

Authorized and approved for distribution:

Michelle Sams

MICHELLE SAMS, Ph.D.
Director

Technical review by

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14. ABSTRACT *(Maximum 200 words)*:

The Army offers a variety of enlistment incentives to encourage applicants to choose Military Occupational Specialties (MOS) where the need is greatest. MOS incentive types, levels, amounts, and qualification criteria are determined by the Enlistment Incentive Review Board (EIRB). To help the EIRB effectively and efficiently perform this function, this research reviewed current incentive policy decision making process and tools, estimated a Job Choice Model (JCM) based on actual applicant choice data from the Army's Recruit Quota System (REQUEST) for the first and second quarters of FY 2010, and developed a proof-of-concept Decision Support Tool (DST) based on the JCM for predicting the number of enlistments by MOS and Term of Service (TOS) and associated cost given a user-defined policy scenario. The effects of incentives on applicant enlistment choices estimated by the JCM were intuitive for simple policy changes and more difficult to anticipate for more complex policy changes. The benefit of the JCM is that effects of policy changes on MOS fill and budget can be quantified objectively. The proof-of-concept DST demonstrated the value of a tool for informing the EIRB in allocating incentives to MOS and TOS enlistment options that can provide the most benefit to the Army.

15. SUBJECT TERMS

Enlistment Incentive Review Board, Army enlistment incentives, discrete choice modeling, job choice modeling and simulation, Army classification

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Tirso E. Diaz, and Paul J. Sticha
Human Resources Research Organization

Paul Hogan
The Lewin Group

Pat Mackin
SAG Corporation

Peter Greenston
U.S. Army Research Institute

Personnel Assessment Research Unit
Michael G. Rumsey, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926

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Personnel, Performance and Training Technology

DETERMINANTS OF THE ARMY APPLICANT JOB CHOICE DECISION AND THE DEVELOPMENT OF A DECISION SUPPORT TOOL FOR THE ENLISTMENT INCENTIVE REVIEW BOARD

EXECUTIVE SUMMARY

Research Requirement:

The Army offers a variety of enlistment incentives to encourage applicants to choose their Military Occupational Specialty (MOS) where the need is greatest. The incentives might include any of several cash bonuses, as well as educational support and repayment of educational loans. Qualification for a bonus depends on both characteristics of the applicant (e.g., aptitude), and the MOS and Term of Service (TOS) selected. MOS incentive types, levels, amounts, and qualification criteria are determined by the Enlistment Incentive Review Board (EIRB) as part of its quarterly review process. In order to set the levels and types of incentives that maximize their effectiveness in encouraging applicants to select high-priority MOS, while minimizing the total cost of incentives required to meet accession requirements, the EIRB needs knowledge about the process that applicants use to decide among the MOS that they are offered.

The goals of this effort are to develop models and organize them into a general analytical tool that can be used to help the EIRB to allocate incentives to the MOS and TOS options to provide the greatest incremental benefit to the Army.

Procedure:

To meet the goals of this research, we reviewed how decisions regarding enlistment incentives are made by meeting with members of the EIRB and evaluating existing tools that they use to assist in incentive policy decisions. Our review indicates that the EIRB currently focuses on characterizing the magnitude of shortfalls by MOS. To complement these efforts, a tool is needed that the EIRB can use to assess the effectiveness of incentives to reduce these shortfalls. To develop such a tool, we specified, estimated, and validated a Job Choice Model (JCM; Diaz, Ingerick, & Sticha, 2007a; Diaz, Ingerick, & Sticha, 2007b) that captures Army applicants' MOS and TOS enlistment preferences as a function of enlistment incentives. A previous version of this model was employed to analyze the impact of increasing the bonus cap to $40K on enlistment choices of applicants. We estimated the JCM using actual applicant choice data from the first and second quarters of FY 2010. We then implemented the analysis capabilities of the JCM as a proof-of-concept Decision Support Tool (DST) that allows users to specify incentive policy scenarios, predict the number of applicant enlistments by MOS and TOS and associated cost for each policy scenario, and compare the results across different policy scenarios.

Findings:

The estimated JCM was demonstrated to meaningfully characterize the effects of incentives on applicant enlistment choices. For simple policy changes the effects were intuitive while for complex policy changes the effects were more difficult to anticipate. In both cases, the benefit of using the JCM is that the effects of policy changes on MOS fills and budget can be measured or quantified objectively. The proof-of-concept DST also demonstrated the value of a tool for informing the EIRB in the allocation of incentives to MOS and TOS enlistment options.

Utilization and Dissemination of Findings:

A DST that implements a JCM like the one developed in this research can be a valuable tool for informing the EIRB in the allocation of incentives to MOS and TOS enlistment options in order to provide the most benefit to the Army. In the (planned) second phase of this research, a prototype DST will be developed with a more robust forecasting / simulation mode for sponsor use.

The results of this research were briefed to the Army Deputy Chief of Staff, G-1 (Enlisted Incentives Branch) and the Assistant Secretary of the Army for Manpower and Reserve Affairs on 28 March 2011 and on 5 October 2011.

DETERMINANTS OF THE ARMY APPLICANT JOB CHOICE DECISION AND THE DEVELOPMENT OF A DECISION SUPPORT TOOL FOR THE ENLISTMENT INCENTIVE REVIEW BOARD

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Research Requirement

Army recruitment activities are conducted to meet the continuing need for Soldiers who are qualified to perform each of the entry-level jobs required for an effective military force. These efforts culminate in a transaction in which an applicant, with assistance from a guidance counselor, selects an initial Military Occupational Specialty (MOS) and term of service (TOS). The scope of MOS offered to an applicant is filtered to reflect applicant window of availability, training seat schedules, and the Army's MOS fill requirements. In addition, the MOS offered to an applicant are those for which the applicant is qualified, based on scores from the Armed Services Vocational Aptitude Battery (ASVAB).

To encourage the applicant to choose MOS where the need is greatest at a longer TOS, the Army offers a variety of enlistment incentives. The incentives might include any of several cash bonuses, as well as educational support and repayment of educational loans. Qualification for a bonus depends on both characteristics of the applicant (e.g., aptitude), and the MOS and TOS selected. MOS incentive types, levels, amounts, and qualification criteria are determined by the Enlistment Incentive Review Board (EIRB) as part of its quarterly review process.

In order to set the levels and types of incentives that maximize their effectiveness in encouraging applicants to select high-priority MOS, while minimizing the total cost of incentives required to meet accession requirements, the EIRB needs knowledge about the process that applicants use to decide among the MOS that they are offered. Along this vein, survey research was conducted by the U.S. Military Academy (USMA) to assess which preferences of youth could be influenced by incentives (Joles, Charbonneau, & Barr, 1998; Henry, Dice, & Davis, 2001). More recent research (Diaz, Ingerick, & Sticha, 2007a, b) has developed job-choice models (JCMs) based on the decisions made by actual applicants for military service as they review the jobs that are offered to them by the Army's Recruit Quota System (REQUEST). These models have the potential to provide the EIRB with information that can help it adjust incentives to increase their effectiveness or to reduce their cost.

The goals of this effort are to develop models and organize them into a general analytical tool that can be used to help the EIRB in the allocation of incentives to the MOS and TOS options in order to provide the greatest incremental benefit to the Army. To meet this goal, we have examined the process by which enlistment incentives are set, developed general JCMs that can support this process, and organized the JCMs into an analytical tool that makes model results available to EIRB members.

This report is organized as follows. First, we review how decisions regarding enlistment incentives are made and summarize previous research to develop JCMs. Second, we discuss the development of a JCM that is applicable to the current problem, describe estimation results and interpret the JCM parameters. Third, we describe the analytic capabilities of a proof-of-concept decision support tool (DST) based on the JCM. Finally, we discuss key findings, limitations of current analysis capabilities, and provide recommendations for future research.

Background

In this section, we give a brief background of how decisions regarding enlistment incentives are made and a summary of previous research to develop JCMs.

How Decisions about Incentives Are Made

Incentive decisions are made by the EIRB. The primary members of the EIRB are the Army Deputy Chief of Staff, G-1, Enlisted Incentives Branch; the Human Resources Command, Enlisted Personnel Management Division (EPMD), Accessions Management Branch (AMB); and the U.S. Army Recruiting Command (USAREC). In addition, EIRB meetings are attended by representatives from Reserve and Guard organizations. Both AMB and USAREC make recommendations regarding the level of incentives that should be offered to applicants as a function of MOS. At the EIRB meetings, these recommendations are reviewed and differences reconciled. A memorandum reflecting the results of the meeting is promulgated to establish the incentive levels for the following quarter.

USAREC MOS Ranking Model.

USAREC uses an MOS ranking model to assess the need for incentives for each MOS, ranks the MOS according to this need, and partitions the MOS into groups to reflect the ranking. The model is constructed in an Excel™ spreadsheet. We reviewed the formulas for a preliminary version of this spreadsheet to get an understanding of the factors that went in the ranking and the recommended incentive levels. Since the spreadsheet was not in final form, it likely was different in some details from the version actually used by USAREC. Nevertheless, we believe that the overall organization of the model is fairly represented in the following discussion.

The model considers the following factors in determining the overall MOS rank:

- *Current Year Fill.* This factor aggregates several measures of the fill for an MOS during the current fiscal year (FY), including the overall fill, the relative fill compared to other MOS, and the fill of quality accessions. The overall fill considers year-to-date accessions, future accessions in the delayed entry program (DEP), and the total contracts for the FY.
- *Past Year Fill.* This factor aggregates three measures of fill for the previous FY, including overall fill, relative fill, and the non-prior service (NPS) program.
- *AMB Priorities.* This factor represents the AMB priority category for the MOS.
- *Near Term Seats.* This factor assesses the percentage of open seats for an MOS that occurs in the next quarter.
- *Easy Sell.* This factor is a direct entry that indicates whether the MOS is substantially easier or harder to sell than average.
- *Open Seats.* This factor represents the total number of open seats for an MOS in the current FY.
- *Top 25 MOS.* The scale for this factor was not set in the version of the model that we reviewed. The factor is calculated based on the following factor, so it may be redundant.
- *Thirty-six critical MOS.* This factor represents the criticality of the most critical MOS.

The overall MOS score is a weighted linear combination of these factors. The relative importance of the factors in determining the overall score for an MOS (and hence its rank) depends on the range of the scale and the weights assigned to them in the linear combination. Table 1 shows both of these items for each of the primary factors in the model. With the exception of near term open seats, which receives a weight of 0.0, the weights are similar, varying only by 10%. The ranges implied in the scale vary to a much greater extent. The first three factors—current year fill, past year fill, and AMB priorities—account for nearly 90% of the total of all weights. In fact, the single factor representing current year fill represents about two-thirds of the total weight in the MOS scores.

Table 1. Importance of Factors in Determining MOS Score for USAREC MOS Ranking Model

Column	Description of Factor	Weight	Minimum Scale Score	Maximum Scale Score	Range	Relative Range	Weighted Range	Weighted Relative Range
AM	Current Year Fill Factors	1.00	-113	111	224	66%	224	67%
AN	Past Year Fill Factors	1.00	-13	28	41	12%	41	12%
AP	AMB Priorities	1.10	0	36	36	11%	39.6	12%
AR	Near Term Open Seats	0.00	0	10	10	3%	0	0%
AW	Easy Sell MOS	1.10	-10	10	20	6%	22	7%
AS	Open Seats	1.05	1	6	5	1%	5.25	2%
AU	Top 25 MOS	1.05	0	0	0	0%	0	0%
AV	36 Critical MOS	1.00	0	3	3	1%	3	1%
Total					339	100%	334.85	100%

The MOS are then placed into groups according to their scores. Cut scores between groups are set and examined to ensure that the distribution of MOS into groups is reasonable. Problems with the model are addressed by changing the cut scores or the factor weights.

The MOS Ranking Model is the first step in the USAREC process in preparing for the EIRB meeting. In addition to the MOS Ranking Model, USAREC examines Recruiting Operations Center (ROC) training seat fill statistics for the year to date and for future months. It also compares the average term of service (TOS), percentage fill, and enlistment bonus (EB) amount to Army averages to identify those jobs that may require additional incentives. Using these three information sources, USAREC recommends whether incentives should increase, decrease or remain the same for the next quarter for each MOS. It then forecasts the total EB cost for the remainder of the FY and compares this number to the forecasted cost for the previous bonus levels. The recommendations are then reconciled with those from AMB at the EIRB meeting.

AMB Recruiting Priority Model

The model used by AMB to determine the recruiting priority of MOS is similar in several respects to the USAREC MOS Ranking Model. Both develop an overall priority score that is a weighted linear combination of several factors. Like the USAREC model, the AMB Recruiting Priority Model includes factors describing MOS fill and criticality. However, the two models differ in many of the specific factors used. We received a printed version of the model, which allowed us to identify the factors that were used to determine the priority of each MOS and specify the scales that were used to assess each factor. We did not receive an electronic version of the model, and so we were unable to verify its operation in detail.

The AMB Model considers the following factors in estimating an MOS recruiting priority.

- Analyst Projection Assistance System (APAS) Delta
- Critical MOS
- Current priority
- Current Top 25
- Army Strategic Readiness Update (ASRU) MOS
- Recruiting history
- Year-to-date targets
- FY targets
- Training constraints
- Hard Start
- Qualification requirements
- Security clearance
- HS or higher education level
- Deployers
- Training Resource Arbitration Panel (TRAP) actions to add/remove seats
- Critical & less than 100%
- Fill remaining during window

Examination of the factor and overall scores suggested that the factors were equally weighted in determining the MOS priority. Consequently, the importance of a factor in determining the overall score depended on the range of scale values. Table 2 shows that, in general, the AMB model weights factors much more equally than the USAREC model. Note that training constraints had no variability among MOS (because no MOS were constrained), so this factor had no impact in the overall ranking of scores. However, the maximum score possible for this factor is five. Consequently, if there had been variability, the relative range of the factor would have been 2%.

Table 2. Importance of Factors in Determining MOS Score for AMB Recruiting Priority Model

Column	Description of Factor	Minimum Scale Score	Maximum Scale Score	Range	Relative Range
H	APAS Delta	0	20	20	9%
I	Critical MOS	0	20	20	9%
J	Current Priority	0	20	20	9%
K	Current Top 25	0	10	10	4%
L	ASRU MOS	0	10	10	4%
M	Recruiting History	0	10	10	4%
N	Year-to-date Targets	0	30	30	13%
O	FY Targets	0	10	10	4%
P	Training Constraints	0	0	0	0%
Q	Hard Start	0	10	10	4%
R	Quals	0	10	10	4%
S	Security Clearance	0	8	8	3%
T	HS or Higher Ed Level	0	10	10	4%
U	Depolyers	0	20	20	9%
V	TRAP	5	20	15	6%
W	Critical & < 100%	0	10	10	4%
Y	Fill remaining during Window	0	20	20	9%
Total				233	100%

Modeling the Recruit Decision Process

The applicant job-choice process is one of the keys to classification in the Army. Information about how applicants choose their initial Army jobs could be used to design more effective and more efficient incentive strategies. In an attempt to provide this information, Joles, Charbonneau, and Barr (1998) and Henry, Dice, and Davis (2001) conducted surveys to assess the extent to which preferences of youth could be influenced by incentives. They used a market research method called choice-based conjoint analysis to estimate utility for incentive packages that consisted of MOS, TOS, EB, and loan repayment. Based on the results of the surveys, they demonstrated an optimization method to select the best incentive packages.

More recent research has looked at the decision process directly, and has built job choice models (JCMs) to represent applicants' choices among enlistment options. These JCMs were estimated based on data about the specific MOS and incentives that were presented to applicants working with guidance counselors, as well as the actual choices they made. Modeling of the job-choice process occurred as an outgrowth of a field test of the Enlisted Personnel Allocation System (EPAS; Sticha, Diaz, Greenston, & McWhite, 2007). The focus of EPAS is optimal person-job match to maximize predicted performance (Diaz, Ingerick, & Sticha, 2007a). In that project, a JCM was used to simulate applicant choices, to support the implementation of an unobtrusive, simulation-based evaluation of EPAS.

In a later project, Diaz, Ingerick, and Sticha (2007b) extended the JCM to consider prediction of MOS-TOS combinations, and applied it to analysis of the impact of increasing the bonus cap (for each individual) on enlistment incentives. In response to a difficult recruiting environment, the Army obtained legislative authority to increase the EB program from $20K to $40K. The increased incentives could expand the recruiting market and channel applicants from other MOS into ones with higher incentives. The main focus of the research was to estimate the channeling effects of expanded alternative bonus programs.

To address this question, Diaz et al. (2007b) specified, estimated, and applied a JCM using discrete choice modeling. Based on actual applicant choice data from the first quarter of FY 2005, the JCM jointly modeled applicants' decisions to join or not join the Army, and their choices of MOS training and TOS. To estimate the channeling effects of raising the bonus cap on Army accessions, the researchers applied the JCM to simulate applicants' MOS-TOS choices under both the $20K bonus and the $40K bonus. Overall, the main results of the simulations indicated that: (a) raising the bonus cap to $40K would uniformly channel applicants, particularly high quality applicants, to higher priority MOS and away from low priority ones; (b) raising the cap would attract applicants, particularly higher quality applicants, to somewhat longer TOS for higher priority MOS; and (c) the market expansion effect on the Army's higher aptitude applicant pool could further increase high quality accessions and mitigate potentially harmful channeling effects associated with raising the cap.

The JCM approach has promise to provide more general guidance to the EIRB to estimate the effect of various incentive policies. However, to be useful, the JCM must be able to evaluate the configuration of incentives in a particular policy, not just the overall total. Consequently, the JCM developed for this project must be able to assess the effects of individual incentives, and will require modifications and enhancements from the version that was used by Diaz et al. (2007b).

Using a Recruit JCM to Assist the Decision Making Process

One of the goals of much of the research on the recruit decision process is to develop methods that can better meet the needs of the EIRB member organizations. For example, Joles et al. (1998) listed a dozen needs of the EIRB stakeholders that should be satisfied using an EB allocation model. These needs include the following (excerpted from Joles et al, 1998, p. 23):

- A scientific approach for allocating the EB budget;
- A tool for the efficient and effective allocation of EB incentives, particularly for the priority MOS;
- A means of improving the channeling effect of the EB;
- A business decision support tool for the EIRB;
- A tool that will help the Army to use incentives efficiently;
- A joint understanding of EB options and tradeoffs by USAREC, HRC, and the G-1;
- A better understanding of how the EB affects applicant preferences and recruiting dynamics;
- Aid in determining the appropriate EB budget for a given mission; and
- The ability to determine when bonuses are no longer needed.

Our review of the EIRB process indicates that it focuses primarily on characterizing the magnitude of recruiting shortfalls by MOS, rather than on assessing the effectiveness of incentives to reduce these shortfalls. Since incentives are adjusted on a quarterly basis, and there is not currently a suitable body of research to estimate the impact of a package of incentives on recruit MOS choice, focusing on current shortages is a reasonable strategy. The existing incentive policy can be adjusted to increase incentives for MOS that are underfilled and to decrease incentives for MOS that are overfilled. If the changes are either insufficient or excessive, they can be adjusted at the next quarter.

However, this adjustment strategy can be improved in several ways by incorporating knowledge of recruit job choice processes. In the first place, although the current system identifies the relative magnitude of recruiting problems by MOS, it is less suited for determining the absolute magnitude of incentives that should be offered. For example, recent quarters have seen a reduction in the overall level of incentives for all MOS, reflecting the unfavorable employment conditions along with increased demand for military service. To the extent that the reduction is insufficient, the Army is paying more than is necessary for its personnel. On the other hand, if the reduction is excessive, then the Army will not be able to fill certain MOS. The effects of incentive changes will be especially difficult to anticipate for MOS that change in their relative standing at the same time that the absolute overall incentive level is also changing. A properly calibrated JCM can provide some insights into the effects of absolute changes in incentive level. While unlikely that it would select the incentive level that meets MOS accession requirements at the lowest possible cost in all conditions, it would provide a reasonable estimate that would improve on existing methods and could be adjusted in later quarters.

Second, a JCM provides a much more detailed understanding of the channeling effects of changes in enlistment incentives for a particular MOS. While it is reasonable to expect that applicants will be channeled to an MOS when its incentive is increased, there are few tools to estimate which, if any, other MOS will be adversely affected by the change. This knowledge could be used to anticipate future problems and to consider preemptive changes in incentives to circumvent these problems.

Finally, there are some factors in the current decision process for which the calibrated JCM could provide assistance in obtaining an estimate. For example, the USAREC MOS Ranking Model includes a factor that identifies easy-sell MOS, a factor that seems to indicate an overall preference (or high utility) for the MOS among applicants. It is possible that a JCM could be developed to provide an empirical estimate for this factor.

Modeling Applicant Job Choices

We used the choice model developed by Diaz, Ingerick, and Sticha (2007b) to analyze the impact of increasing the bonus cap to $40K on the MOS-TOS enlistment choices of applicants as the starting point of the JCM for assisting EIRB policy making. Unlike in the bonus cap study where it was sufficient to quantify the pre-cap total bonus corresponding to choices of applicants, the goal of the present research requires greater precision at the incentive level. In particular, for the JCM to be informative to the EIRB it must be able to directly measure the effects of the EB, the Army College Fund (ACF), and the Loan Repayment Program (LRP) incentives that are used to define the levels of incentives.

Specifying Applicant Choice Space

The applicant choice space in this research is based on the two-dimensional (MOS, TOS) choice space employed in the bonus cap study. The original choice space was modified in two ways to enhance the application of the JCM in the EIRB decision process. First, we expanded the number of MOS alternatives by shredding the 36 MOS alternatives in the bonus cap study into smaller sets of alternatives. The goal in this process was to obtain aggregated MOS alternatives that are more similar with respect to the MOS incentive levels in place during the first two quarters (denoted Q1 and Q2) of FY 2010.[1] When possible we created separate alternatives for high density MOS. Second, we expanded the choice space by adding a third dimension to indicate the type of incentive package chosen by the applicant (i.e., a full cash bonus or a reduced cash bonus with ACF/LRP). Including the type of chosen incentive in the JCM enables direct estimation of the effects of enlistment cash bonus and ACF/LRP incentives on applicant enlistment choices. Some special considerations were necessary to add the type of incentive to the original (MOS, TOS) choice space, as described below.

Note that MOS and TOS remain the primary dimensions on which applicant choices will be evaluated, while the type of incentive will be viewed as an auxiliary dimension that is essential for more precise modeling of an applicant's choice process. In the following we will use the triplet (m,t,k) to indicate an applicant's three-dimensional choice space, with indices m and t identifying the MOS and TOS chosen by the applicant and index k identifying the type of chosen incentive.

We first describe the construction of the choice subspace (m,t) followed by a detailed description of the choice dimension k. We constructed the two-dimensional primary choice subspace (m,t) using the strategy employed in the bonus cap study. As mentioned above, we started with the 36 MOS alternatives and considered shredding each to produce new aggregated MOS alternatives that are homogeneous relative to the current MOS incentive levels. Shredding the original MOS alternatives, rather than starting anew, preserved the similarity in job content of MOS belonging to the same MOS alternative as determined in the bonus cap study. We then cross-tabulated applicants MOS and TOS enlistment choices using the reconfigured MOS alternatives dimension to identify (m,t) combinations to consider for the JCM. Combinations of

[1] Reconfiguring the MOS alternative dimension will also involve matching the new MOS alphanumeric labels to the old MOS alphanumeric labels in place at the time of the bonus cap study.

MOS and TOS with extremely low densities were dropped from the choice space. There were 152 MOS-TOS alternatives left after dropping extremely low density combinations whose total accounted for less than 0.3 percent of the data. The reconfigured MOS-TOS choice subspace represents a 46 percent increase compared to the 104 total alternatives in the bonus cap study.

Table 3 shows the expanded MOS dimension with 55 alternatives. Note that the first three characters in the new MOS alternative labels identify the MOS alternative in the bonus cap configuration. We retained the original MOS clusters and reduced MOS clusters which were used previously to identify MOS alternatives that have similar job content and likely have correlated utilities.

Next, we describe the construction of the choice dimension representing the type of incentive. Possible values for the additional dimension indicating the type of incentive, *k*, are described below in terms of incentive packages listed in the military personnel (MILPER) messages to the field:

$$k = \begin{cases} 1 & , \quad \text{Full Cash Bonus (EB - only)} \\ 2 & , \quad \text{Reduced Cash Bonus (EB + ACF/LRP or ACF/LRP - only)} \\ 3 & , \quad \text{No EB/ACF/LRP Incentive} \end{cases}$$

The choice index *k*=1 corresponds to the full cash bonus (EB-only) incentive package; *k*=2 corresponds to the reduced cash bonus (EB+ACF/LRP) or ACF/LRP-only incentive packages; and index *k*= 3 corresponds to non-availability of EB/ACF/LRP incentives. For modeling purposes, we view the ACF/LRP-only package as an EB+ACF/LRP package with reduced cash bonus equal to zero. Not all values for *k* may be combined with each of the 152 MOS-TOS in the three-dimensional choice space, as discussed below.

In defining the expanded choice space, we combined the type of incentive package (*k*=1,2, 3) with the (*m,t*) alternative subspace using the following rules:

(1) *For non-incentivized (m,t) alternatives, k=3 is the only possible incentive option.* This is a consequence of the way alternatives are defined.

(2) *For (m,t) alternatives with an ACF/LRP-only incentive, k=2,3 are the two possible incentive options.* In other words, applicants choosing an (*m,t*) alternative that only offers an ACF/LRP incentive may choose to take the incentive (*k*=2, with zero reduced cash and non-zero ACF/LRP) or decline the incentive (*k*=3) if it has no value to him/her. The latter very likely would be the case if an applicant already completed college and had no student loan.

(3) *For incentivized (m,t) alternatives with a non-zero (full or reduced) cash bonus, k=1,2 are the two possible incentive options.* Here we are making the assumption that an applicant will not decline a cash bonus no matter how small. This is a meaningful behavioral assumption and, as will be shown later, only a fractional percentage of applicants declined a cash bonus that was available in their chosen MOS and TOS (see Table 4).

Table 3. MOS Alternative Configuration and Clusters

Alternative ID	Alternative Label	Cluster*	Reduced Cluster	MOS
1	11X1	1	1	11B, 11C, 11X
2	13F1	2	1	13F
3	FA11	2	1	13D
4	FA12	2	1	13B, 13M,
5	FA21	2	1	13R
6	FA22	2	1	13P, 13S,
7	FA23	2	1	13T, 13W,
8	AD11	2	1	14J
9	AD12	2	1	14E, 14S, 14T
10	AV11	7	4	15J
11	AV12	7	4	15B, 15D, 15E, 15F, 15G, 15H, 15N, 15R, 15S, 15T, 15U, 15Y,
12	AV21	7	4	15P, 15Q,
13	18X1	1	1	18X
14	19D1	1	1	19D
15	19K1	1	1	19K
16	EN11	10	7	21Y
17	EN12	10	7	12D, 12M, 12N, 12R, 12T, 12W, 21D, 21E, 21K, 21M, 21R, 21T, 21V, 21W, 91E, 91L, 91W
18	EN21	10	7	21B, 21C,
19	SI11	14	10	25R
20	SI12	14	10	25B, 25M, 25V
21	SI21	3	2	25P, 25S,
22	SI22	3	2	25Q
23	SI23	3	2	25F, 25N, 25U
24	SI24	3	2	25C, 25L,
25	PA11	4	3	46Q, 46R,
26	PA12	4	3	37F
27	LE11	4	3	31B, 31E,
28	EL11	6	4	94A, 94D, 94E, 94F, 94M, 94S, 94Y
29	EL12	6	4	68A, 91C, 94H, 94K, 94L, 94P, 94R, 94T,
30	EL21	6	4	35T
31	AX11	8	5	27D
32	AX12	8	5	56M
33	AX13	8	5	36B, 42A, 42F
34	AM11	11	4	91F, 91G, 91K
35	52D1	5	4	91D
36	VM11	5	4	91M
37	VM12	5	4	91H, 91J, 91P
38	VM21	5	4	91A, 91B,
39	74D1	13	9	74D
40	TR11	9	6	88H, 88K, 88L, 88N,

* MOS-Cluster Titles: 1=Close Combat; 2=Non Line-of-Sight Fire; 3=Surveillance, Intelligence, and Communications; 4=Security and Civil Affairs; 5=Mechanical Maintenance Repair; 6= Electronics Maintenance Repair; 7=Aircraft Maintenance Repair; 8=Administration; 9=Logistics/Supply Support; 10=Heavy Equipment Operator; 11=Craftworker; 12=Medical Care, Health, and Well-Being; 13=Skilled Science Technician; 14=Media Specialist

Table 3. MOS Alternative Configuration and Clusters (cont'd)

Alternative				
ID	**Label**	**Cluster***	**Reduced Cluster**	**MOS**
41	88M1	9	6	88M
42	89D1	4	3	89D
43	89B1	9	6	89A, 89B,
44	MD11	12	8	68K
45	MD12	12	8	68D, 68E, 68G, 68H, 68J, 68M, 68P, 68Q, 68R, 68S, 68T, 68V, 68X
46	MD13	12	8	68W
47	92F1	9	6	92F
48	92G1	9	6	92G, 92R,
49	SL11	9	6	92A, 92L, 92M, 92S, 92W, 92Y,
50	IN11	3	2	35W
51	IN12	3	2	35H
52	IN13	3	2	35N
53	IN14	3	2	35F, 35G, 35S
54	HI11	3	2	35M
55	15W1	7	4	15W

* MOS-Cluster Titles: 1=Close Combat; 2=Non Line-of-Sight Fire; 3=Surveillance, Intelligence, and Communications; 4=Security and Civil Affairs; 5=Mechanical Maintenance Repair; 6= Electronics Maintenance Repair; 7=Aircraft Maintenance Repair; 8=Administration; 9=Logistics/Supply Support; 10=Heavy Equipment Operator; 11=Craftworker; 12=Medical Care, Health, and Well-Being; 13=Skilled Science Technician; 14=Media Specialist

Overall there will be fewer than 152×3 (*m,t,k*) alternatives in the expanded choice space. For estimation and simulation purposes, the three rules above are separately applied to each *(m,t)* enlistment opportunity of an applicant based on the available types of EB/ACF/LRP packages in the REQUEST data.

Table 4 summarizes the distribution of the types of incentive (*k*=1,2,3) chosen by applicants for each of two sets of incentives expected in a REQUEST job list. Incentive Set "A" means that the full cash bonus (EB-only) incentive and the reduced cash bonus (EB+ACF/LRP) or ACF/LRP-only incentives are available in the REQUEST list. As indicated in MILPER messages, either EB+ACF/LRP or ACF/LRP-only is always offered as a substitute for an EB-only incentive. Incentive Set "B" means that only an ACF/LRP incentive is available in the REQUEST list.[2] The table reports the frequency and percentage distribution of different incentives within incentive sets A and B by TOS. The results are reported for all applicants combined and by education status.

Table 4 shows that, overall, applicants are relatively less likely to choose the reduced cash bonus (*k*=2) in incentive set A when signing up for longer TOS (5 or 6) compared to shorter TOS (3 or 4). While preference for the full cash bonus is consistent across education status categories, it is less pronounced for applicants with some college or higher education than with seniors or high school graduates. In other words, for applicants with some college or higher education, the ACF/LRP component in the reduced cash bonus package retains its value, even with an increasing full cash bonus from TOS=3 to TOS=6. This education status-type of incentive interaction is not surprising, as applicants with college or higher education tend to have future college education to fund or existing student loans to pay. To a lesser extent, seniors also appear to value the ACF incentive more compared to high school graduates. In formulating the JCM, we specified the utility equations to capture the interaction described here. Note that Table 4 also shows that only a fractional percentage of applicants were recorded to have declined an enlistment cash bonus that was available in their chosen MOS-TOS enlistment alternative, lending support to behavioral / policy restriction (3) above.

In sum, we used the MOS alternatives in the bonus cap study as a starting point in constructing the applicant choice space. Modifications were made, namely, shredding the original 36 MOS alternatives into more homogeneous alternatives and adding a dimension in the choice space for the type of incentive. These modifications enhance how incentives levels are represented in the JCM, enhancing the JCM's capability to measure the relationship between EB/ACF/LRP incentives and applicant enlistment choices and its potential value for the EIRB.

[2] Not shown in the table is Package type "C" which means that only the full cash bonus was available in the job list. This is inconsistent with MILPER messages and very likely is a data error as evidenced by its negligible percentage.

Table 4. Applicants' Chosen Incentives by Type of Incentive Package

Education Status	Type of Chosen Incentive	TOS=3				TOS=4				TOS=5				TOS=6			
		Package A		Package B		Package A		Package B		Package A		Package B		Package A		Package B	
		N	Pct	N	Pct	N	Pct	N	Pct	N	Pct	N	Pct	N	Pct	N	Pct
Overall	EB	398	52.6	23	0.5	1,561	64.0	13	0.5	779	69.9	0	0.0	1,267	85.9	2	0.6
	EBACF	204	27.0	7	0.1	238	9.8	2	0.1	57	5.1	1	1.2	91	6.2	1	0.3
	EBLRP	58	7.7	1	0.0	44	1.8	0	0.0	47	4.2	0	0.0	38	2.6	0	0.0
	ACF	40	5.3	3,538	69.7	547	22.4	2,182	82.3	146	13.1	76	93.8	74	5.0	280	80.2
	LRP	34	4.5	484	9.5	40	1.6	158	6.0	77	6.9	2	2.5	3	0.2	20	5.7
	None	22	2.9	1,021	20.1	9	0.4	295	11.1	9	0.8	2	2.5	2	0.1	46	13.2
	TOTAL	*756*	*100.0*	*5,074*	*100.0*	*2,439*	*100.0*	*2,650*	*100.0*	*1,115*	*100.0*	*81*	*100.0*	*1,475*	*100.0*	*349*	*100.0*
College+	EB	69	36.7	3	0.3	206	53.9	3	0.5	187	53.7	0	0.0	192	73.0	0	0.0
	EBACF	40	21.3	0	0.0	29	7.6	0	0.0	9	2.6	0	0.0	21	8.0	1	1.5
	EBLRP	46	24.5	1	0.1	31	8.1	0	0.0	40	11.5	0	0.0	30	11.4	0	0.0
	ACF	8	4.3	579	51.1	80	20.9	426	66.6	41	11.8	11	84.6	18	6.8	44	64.7
	LRP	23	12.2	387	34.1	33	8.6	128	20.0	68	19.5	1	7.7	2	0.8	14	20.6
	None	2	1.1	164	14.5	3	0.8	83	13.0	3	0.9	1	7.7	0	0.0	9	13.2
	TOTAL	*188*	*100.0*	*1,134*	*100.0*	*382*	*100.0*	*640*	*100.0*	*348*	*100.0*	*13*	*100.0*	*263*	*100.0*	*68*	*100.0*
HSDG	EB	287	57.5	20	0.6	1,116	67.3	7	0.4	512	79.0	0	0.0	928	89.9	1	0.5
	EBACF	147	29.5	7	0.2	171	10.3	2	0.1	38	5.9	1	1.9	54	5.2	0	0.0
	EBLRP	12	2.4	0	0.0	13	0.8	0	0.0	7	1.1	0	0.0	8	0.8	0	0.0
	ACF	23	4.6	2,450	74.1	346	20.9	1,364	86.5	76	11.7	50	94.3	39	3.8	182	83.9
	LRP	11	2.2	97	2.9	7	0.4	29	1.8	9	1.4	1	1.9	1	0.1	6	2.8
	None	19	3.8	733	22.2	5	0.3	174	11.0	6	0.9	1	1.9	2	0.2	28	12.9
	TOTAL	*499*	*100.0*	*3,307*	*100.0*	*1,658*	*100.0*	*1,576*	*100.0*	*648*	*100.0*	*53*	*100.0*	*1,032*	*100.0*	*217*	*100.0*
Senior	EB	42	60.9	0	0.0	239	59.9	3	0.7	80	67.2	0	0.0	147	81.7	1	1.6
	EBACF	17	24.6	0	0.0	38	9.5	0	0.0	10	8.4	0	0.0	16	8.9	0	0.0
	EBLRP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	ACF	9	13.0	509	80.4	121	30.3	392	90.3	29	24.4	15	100.0	17	9.4	54	84.4
	LRP	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0
	None	1	1.4	124	19.6	1	0.3	38	8.8	0	0.0	0	0.0	0	0.0	9	14.1
	TOTAL	*69*	*100.0*	*633*	*100.0*	*399*	*100.0*	*434*	*100.0*	*119*	*100.0*	*15*	*100.0*	*180*	*100.0*	*64*	*100.0*

Specifying Applicant Choice Model

We used discrete choice modeling to relate applicant enlistment choices to the attributes of the enlistment alternatives and characteristics of the applicants. As in the bonus cap study, we employed the mixed multinomial logit (MMNL) model (Train, 1986; Ben-Akiva & Lerman, 1985; Green 2000) given strong similarity among MOS alternatives. Under this condition, the independence from irrelevant alternatives assumption underlying the simpler multinomial logit model will not hold. In practical terms, a choice model based on this assumption will produce an unrealistic MOS substitution pattern or channeling effect. In the following discussion we specify the utility equations for the (*m,t,k*) enlistment alternatives and present the JCM probability function that relates applicant enlistment choices to applicant characteristics and alternative attributes.

While the utility or value that an applicant places on an enlistment alternative will only be known to the applicant, it can generally be explained in part or modeled by a researcher through a utility equation. This equation represents the value of an alternative to an applicant as a function of observable characteristics of the applicant and attributes of the alternative. In this research, we expanded the utility equations previously specified in the bonus cap study to more precisely measure the effect of the EB/ACF/LRP incentives on applicant preferences. As in the bonus cap study, the utility equations for the present JCM include systematic utility and error components. These components are shown below using the general form of the utility equation:

$$U_{i,m,t,k}(X,Z) = V_{i,m,t,k}(X,Z) + F_{i,c(m),t,k} + E_{i,m,t,k}\,.$$

The term $V_{i,m,t,k}(X,Z)$ represents the systematic component of utility, which relates the (*m,t,k*) alternative to the characteristics (Z) of the *i*th applicant and attributes (X) of the enlistment alternative. The term $F_{i,c(m),t,k}$ represents an error component shared by MOS alternatives with similar job requirements belonging to the MOS cluster *c(m)* (see Table 3), and is presumed to be related to unobserved characteristics of applicants. The term $E_{i,m,t,k}$ represents an unobserved utility or error term that is unique to an alternative. From a researcher's point of view, $V_{i,m,t,k}(X,Z)$ is the observable or predictable part of an applicant's choice behavior and $F_{i,c(m),t,k} + E_{i,m,t,k}$ is the unobservable part of choice behavior. The specific forms of these components are described in detail below.

Note that the error component specification above induces a positive correlation between utilities within an MOS cluster. Behaviorally, for an applicant, this means alternatives within a given MOS cluster are better substitutes for each other than alternatives in other MOS clusters. This substitution pattern will produce more realistic channeling effects and is important in forecasting applications of the JCM.

Table 5. List of Alternative Attributes and Applicant Characteristics Used in the JCM

Name	Description
MOS/TOS-Specific Incentives:	
• $X_{EB1,i,m,t}$	Enlistment Bonus (EB) available to the *i*th applicant for the *m*th MOS and *t* years of TOS. This is Army's primary monetary incentive tool and is offered in increasing dollar amounts by priority level of an MOS.
• $X_{EB2,i,m,t}$	Reduced amount of EB available to the *i*th applicant for the *m*th MOS and *t* years of TOS when EB is combined with ACF.
• $X_{AL,i,m,t}$	Indicator variable representing the availability of ACF/LRP to the *i*th applicant for the *m*th MOS and *t* years of TOS.
• $X_{HG,i,m}$	High Grad (HG) bonus available to the *i*th applicant for the *m*th MOS. This cash bonus is available to applicants with varying levels of college education (at least 30 or 60 college credit hours, and AB or associate degrees).
• $X_{SB,i,m}$	Seasonal Bonus (SB) available to the *i*th applicant for the *m*th MOS. The SB incentive is used to encourage enlistment to near term training classes. It is offered at three levels depending on how close training start date is at the time of transaction at the MEPS.
• $X_{RB,i,m}$	Ranger Bonus (RB) available to the *i*th applicant for the *m*th MOS.
• $X_{DEB,i,m}$	Deferred Enlistment Bonus (DEB) available to the *i*th applicant for the *m*th MOS.
Demographic Variables:	
• $Z_{sexM,i}$	Gender indicator variable (1=Male, 0=Female)
• $Z_{edC,i}$	Indicator variable for education status beyond high school graduate (i.e., at least some college semester hours).
• $Z_{edG,i}$	Indicator variable for high school graduate education status.
• $Z_{edS,i}$	Indicator variable for high school senior education status.
• $Z_{edN,i}$	Indicator variable for not high school graduate education status.
• $Z_{13A,i}$	Indicator variable for AFQT Category I-IIIIA.
• $Z_{AA,i,m}$	Score of the applicant for the Aptitude Area for the *m*th MOS.

Table 6. Bonus Dollar Amounts by Priority Level and Type

Level	Type	TOS=2	TOS=3	TOS=4	TOS=5	TOS=6
FY 2010 Q1 (October 2009)						
1	EB		7K	10K	15K	20K
	EB+ACF	+150	4K+350	5K+650	8K+850	10K+950
	EB+LRP		4K	5K	8K	10K
2	EB		4K	7K	10K	15K
	EB+ACF	+150	2K+350	4K+650	5K+850	8K+950
	EB+LRP		2K	4K	5K	8K
3	EB		2K	3K	6K	8K
	ACF	+150	+350	+650	+850	+950
4	EB			1K	3K	6K
	ACF	+150	+350	+650	+850	+950
5	ACF	+150	+350	+650	+850	+950
FY 2010 Q2 (December 2009)						
1	EB		4K	6K	12K	20K
	EB+ACF	+150	2K+350	3K+650	6K+850	10K+950
	EB+LRP		2K	3K	6K	10K
2	EB		1K	4K	6K	12K
	EB+ACF	+150	1K+350	2K+650	3K+850	6K+950
	EB+LRP		1K	2K	3K	6K
3	EB			1K	4K	6K
	ACF	+150	+350	+650	+850	+950
4	EB				1K	4K
	ACF	+150	+350	+650	+850	+950
5	ACF	+150	+350	+650	+850	+950

Systematic Utility

We first specify the systematic utility as a function of monetary incentives, applicant demographics, and aptitude scores. Changes made to the utility equations in the bonus cap study are mainly related to the addition of type of incentive (*k*) as a third dimension in the choice space. These changes allow effects of the EB/ACF/LRP incentives to be directly (and separately) represented in the utility equation. For the enlistment alternative associated with MOS=*m*, TOS= *t*, and incentive package type *k*, the full systematic utility equation is given by:

$$
\begin{aligned}
V_{i,m,t,k}(X,Z) = {} & A_{M,m} + G_{sexM,c(m)} Z_{sexM,i} + G_{13A,c(m)} Z_{13A,i} + G_{edS,c(m)} Z_{edS,i} + G_{edC,c(m)} Z_{edC,i} \\
& + A_{T,t} + G_{sexM,t} Z_{sexM,i} + G_{13A,t} Z_{13A,i} + G_{edS,t} Z_{edS,i} + G_{edC,t} Z_{edC,i} \\
& + G_{AA} Z_{AA,i,m} \\
& + B_{HG} X_{HG,i,m} + B_{SB} X_{SB,i,m} + B_{AB} X_{AB,i,m} + B_{RB} X_{RB,i,m} + B_{DEB} X_{DEB,i,m} \\
& + B_{EBg1} X_{EBg1,i,m,t,k} + B_{EBs1} X_{EBs1,i,m,t,k} + B_{EBc1} X_{EBc1,i,m,t,k} \\
& + B_{ALg,t} X_{ALg,i,m,t,k} + B_{ALs,t} X_{ALs,i,m,t,k} + B_{ALc,t} X_{ALc,i,m,t,k} \\
& + B_{EBg2} X_{EBg2,i,m,t,k} + B_{EBs2} X_{EBs2,i,m,t,k} + B_{EBc2} X_{EBc2,i,m,t,k} \\
& + B_{BC} \max\left(0, X_{TB,i,m,t,k} - C_t\right)
\end{aligned}
$$

The utility expression above involves characteristics of applicants (Z) and attributes of alternatives (X) defined in Table 5. The variables listed in Table 5 were entered as separate predictors or combined to form interaction terms in the systematic utility. (Interactions are described in more detail below.) The dollar values of cash bonuses and ACF (monthly benefit amount) are shown in Table 6 by incentive level and TOS. The parameters in the utility equation labeled “A” represent alternative-specific constants; parameters labeled “G” represent the effects of applicant characteristics in the form of alternative-subgroup interactions; and parameters labeled “B” represent the effects of monetary incentives and MOS aptitude area scores of applicants.

The first three lines relate the characteristics of the applicants to the MOS and TOS dimensions of enlistment alternatives. The first line in the systematic utility specifies an MOS-specific constant for each alternative and MOS alternative-subgroup interactions based on applicant gender, AFQT category, and education status. To obtain a parsimonious model, the MOS alternative-subgroup interactions were specified to be constant within groups of MOS with similar job requirements based on the 10 reduced clusters. The MOS interaction terms in the first line essentially relate observed characteristics of applicants (gender, education status, and AFQT category) to qualitative attributes of MOS based on job requirements. The subscript notation *c(m)* denotes the MOS cluster to which the *m*th MOS alternative belongs. The second line in the systematic utility specifies a TOS-specific constant for each alternative and TOS-subgroup interactions based on applicant gender, AFQT category, and education status. The third line describes the effect of applicant aptitude area score on MOS preferences; it measures the extent to which applicant preferences and aptitudes match.

Two changes were made in the first three lines compared to the specification in the bonus cap study. First, separate education status interactions were specified for all three main education subgroups, namely, some college or higher, high school graduates, and seniors.[3] This facilitates interpretation of the interaction between education status and type of incentive in the present JCM. Second, the MOS alternative-subgroup interactions in the current research are based on the 10 reduced MOS clusters, as opposed to the 14 MOS clusters in the bonus cap study. Using fewer MOS clusters was necessary given the higher number of parameters in key parts of the utility (e.g., education status and expanded specification of EB/ACF/LRP incentives). Using the 10 MOS clusters also makes the alternative-subgroup interactions consistent with the error components (also specified using the 10 MOS clusters), in turn facilitating interpretation. For example, the error components can be interpreted more readily as unobserved applicant MOS biases not accounted for by applicant subgroups.

The fourth line in the utility expression represents a component of systematic utility explained by monetary incentives that can vary across the MOS-dimension of the alternative space but not specific to MOS levels. There are two incentives, seasonal bonus (SB) and Airborne bonus (AB), that were not offered during the enlistment period covered by the data but included in the utility expression for completeness. We also note that two additional incentives, Ranger bonus (RB) and deferred enlistment bonus (DEB), were not offered during the period covered by the bonus cap study.

The next three lines correspond to the part of utility that is most relevant to the EIRB. These lines separately measures the effect of the full cash bonus package (EB-only) and the reduced cash bonus package (EB+ACF or ACF-only), and include interactions described earlier between the type of chosen incentive and education status. These lines are described in more detail below. The last line is the bonus cap term which ensures that total utility reflects the total bonus constraint specified in the MILPER messages by TOS. We did not record any applicant with total possible bonus ($X_{TB,i,m,t,k}$) that exceeded the bonus cap C_t from the REQUEST transactions data.[4]

The fifth line represents the effect of the full cash bonus. The variables $X_{EBg1,i,m,t,k}$, $X_{EBs1,i,m,t,k}$, and $X_{EBc1,i,m,t,k}$ respectively corresponds to the interaction between the full bonus amount and education status indicator variables for high school graduate, senior, and some college or higher. For example, for seniors, the interaction was computed as: $X_{EBs1,i,m,t,k} = X_{EB1,i,m,t,k} \times Z_{edS,i}$. Note that these variables can only be non-zero for k=1 (EB-only). The sum of the sixth and seventh lines represent the combined effect of the reduced bonus and ACF/LRP-only incentives (i.e., EB+ACF/LRP package). The variables $X_{EBg2,i,m,t,k}$, $X_{EBs2,i,m,t,k}$ and $X_{EBc2,i,m,t,k}$ correspond to the interaction between the reduced bonus and education status,

[3] Only a small fraction of applicants did not obtain a high school diploma. These applicants were grouped with high school graduates when specifying alternative-education status interactions.
[4] Note that this does not mean that it was not possible for an individual to receive the maximum advertised bonus during Q1 and Q2 of FY 2010.

while $X_{ALg,i,m,t,k}$, $X_{ALs,i,m,t,k}$ and $X_{ALc,i,m,t,k}$ correspond to the interaction between the indicator variables representing the availability of ACF/LRP incentives and education status. These variables were computed as shown in the preceding example for the full cash bonus for seniors. Note that the reduced bonus and ACF/LRP availability indicator variables in the sixth and seventh lines can only be non-zero for *k*=2 (EB+ACF/LRP or ACF/LRP-only). For *k*=3, the full and reduced bonus and ACF indicator variables were set to zero.

There were three reasons for using indicator variables to specify *availability* of the ACF/LRP for a given TOS as opposed to treating ACF/LRP as a continuous/quantitative variable. First, based on analysis of the MILPER messages, the range of values for ACF/LRP incentives is limited and does not change across incentive levels or EIRB quarters for a given TOS. Second, the ACF/LRP incentives are maximum dollar amounts. It is difficult to quantify from available data how much each applicant would use out of the maximum possible amount. Third, using an indicator variable to model availability of ACF/LRP also allows the JCM to capture nonlinearities with respect to TOS (as observed in Table 4).

The systematic utility for the decision not to join the Army comprises alternative specific constants and subgroup interactions. It differs from the utility equation specified in the bonus cap study in that there are no socio-economic variables. The full equation is given by:

$$V_{i,999}(X,Z) = A_{M,999} + G_{sexM,999}Z_{sexM,i} + G_{13A,999}Z_{13A,i} + G_{edS,999}Z_{edS,i} + G_{edC,999}Z_{edC,i}$$

Unobserved Utility

As mentioned earlier, we modeled the unobserved utility as $F_{i,c(m),t,k} + E_{i,m,t,k}$, where $F_{i,c(m),t,k}$ is an error component that is shared by MOS alternatives with similar job requirements and $E_{i,m,t,k}$ is a random error that is unique to an alternative. Again, we used the 10 MOS clusters to identify groups of MOS alternatives that have similar job requirements. In specifying the error component, we make the assumption that shared unobserved utilities are related to unobserved characteristics of applicants.

We specified the following distributional assumptions to completely define unobserved utility. We specified $F_{i,c(m),t,k} = \sigma_{c(m)}\xi_{i,c(m)}$, where $\xi_{i,c(m)}$ is a standard normal random variable common to all alternatives in an MOS cluster indexed by *c(m)*, and $\sigma_{c(m)}$ is the standard deviation of the error component. In this specification, the random variables $\xi_{i,c(m)}$ represent unobserved characteristics of applicants (e.g., preference for certain types of jobs), and $\sigma_{c(m)}$ is a scale parameter to be estimated from data. The random variables $\xi_{i,c(m)}$ are assumed to be independent across MOS clusters and applicants. On the other hand, the random utilities $E_{i,m,t,k}$ are specified to be independently distributed across applicants and alternatives as a standard Gumbel distribution with mode zero and variance $\pi^2/6$. The random variables $E_{i,m,t,k}$ and $\xi_{i,c(m)}$ are specified to be independent within and across clusters.

As previously noted, the error component specification for the unobserved utility induces a positive correlation between utilities within an MOS cluster. These correlations simply arise from the covariances of the shared unobserved utilities. For alternatives belonging to the same MOS cluster *c(m)*, this correlation is given by:

$$
\begin{aligned}
\rho_{c(m)} &= corr\left(U_{i,m,t,k}, U_{i,m',t',k'}\right) \\
&= \frac{\operatorname{cov}\left(F_{i,m,t,k} + E_{i,m,t,k}, F_{i,m',t',k'} + E_{i,m',t',k'}\right)}{\sqrt{\operatorname{var}\left(F_{i,m,t,k} + E_{i,m,t,k}\right)\operatorname{var}\left(F_{i,m',t',k'} + E_{i,m',t',k'}\right)}} \\
&= \frac{\sigma_{c(m)}^2}{\sigma_{c(m)}^2 + \pi^2/6}.
\end{aligned}
$$

The rationale for and the structure of the correlation above are the same as in the bonus cap study. However, there are important differences in interpretation. The intra-cluster correlation in the bonus cap study was between alternatives in the two-dimensional (*m,t*) choice space, while the correlation above is between alternatives in the three-dimensional (*m,t,k*) choice space. In specifying the error component in the bonus cap study, we modeled (a) the correlation between alternatives with similar MOS, regardless of TOS and (b) the correlation between alternatives with the same MOS but different TOS to be equal; that is, $corr\left(U_{i,m,t}, U_{i,m',t}\right)$, $corr\left(U_{i,m,t'}, U_{i,m',t'}\right)$, and $corr\left(U_{i,m,t}, U_{i,m,t'}\right)$ are all equal to $\rho_{c(m)}$. Modeling these three correlations to be equal was a simplifying assumption. In the present research, these three types of correlation were also specified to be equal to the correlation between alternatives in a cluster with the same MOS and TOS but different types of incentives; that is, additionally, $corr\left(U_{i,m,t,k}, U_{i,m,t,k'}\right) = \rho_{c(m)}$. This again is a simplifying assumption. Because the last correlation compares two utilities from alternatives that only differ in the type of incentive, it is expected to be higher than the other three correlations. As will be shown later, estimation results suggest that any increase in correlations are low or practically negligible.

Lastly, we also specified an unobservable component, $F_{i,999}$, in the utility of the alternative for not joining the Army. This component appears as an extra term in the utility of applicants who were offered multiple MOS alternatives. The purpose of this random term is to specify heteroscedastic random utility for not joining the Army, therefore differentiating applicants with a single MOS from applicants with multiple MOS in their job list. The grouping of applicants in terms of number of MOS in the job list (single or multiple MOS) will be a function of their preferences relative to the full set of MOS for which they are qualified. Estimation and application of the JCM in this research is conditional on applicants' filtered REQUEST job list and, therefore, on applicant preferences that are partially reflected in these job lists. This heteroscedastic specification posits a smaller variance for applicants deciding between not joining the Army and a single MOS.

Job Choice Probability

We specify below the probability function that relates the systematic and unobserved utilities to an applicant's enlistment choice. Let A_i denote the set of all (*m*,*t*,*k*) enlistment alternatives available to the *i*th applicant. This set can be constructed from an applicant's REQUEST job list, starting with the MOS in the job list, and then combining allowable TOS for each MOS based on the MOS-TOS choice subspace, and lastly combining allowable values *k* for the type of incentive based on the policy/behavioral restrictions described earlier. The probability that applicant *i* chooses alternative (*m'*,*t'*,*k'*) is given by the mixed multinomial logit probability model:

$$P_i(m',t',k') = \int_{\bar{\xi}} \frac{\exp\left(V_{i,m',t',k'}(X,Z) + \sigma_{c(m)}\xi_{i,c(m')}\right)}{\exp\left(V_{i,999}(X,Z) + \sigma_{999}\xi_{i,999}\right) + \sum_{(m,t,k)\in A_i} \exp\left(V_{i,m,t,k}(X,Z) + \sigma_{c(m)}\xi_{i,c(m)}\right)} f\left(\overline{\xi_i}\right) d\overline{\xi_i}$$

The multiple integration above is taken over the vector of standard normal variables $\overline{\xi_i} = \left(\xi_{i,c(1)},\ldots,\xi_{i,c(10)},\xi_{i,999}\right)$ with joint density $f\left(\overline{\xi_i}\right)$, where *V* is the systematic utility expression defined earlier. Note that the form of the integrand is that of a multinomial logit probability model that includes unobserved applicant characteristic $\xi_{i,c(m')}$ as a predictor. For JCM estimation and forecasting, the integration is approximated using random draws from the multivariate normal distribution (Train, 2003). In this research, we are primarily interested in applicants' predicted choice of MOS. The probability corresponding to this choice is obtained by simply summing the three-dimensional probability across (*t*,*k*) values, $P_i(m) = \sum_{t,k} P_i(m,t,k)$.

In sum, we specified the systematic utility equations on the three dimensional choice space (*m*,*t*,*k*) using a form that allows direct measurement of the effect of the full cash and reduced cash incentive packages on applicant enlistment choices. This has important benefits for the application of the JCM in the EIRB process, especially when combined with the interaction of the bonus effects with the education status. In addition to policy simulation applications, the JCM can also guide the EIRB in defining MOS incentive levels. The EIRB, for example, can take into account the type of applicants forecasted for a given quarter by education status when setting the EB and ACF/LRP incentives for each MOS levels. In other words, the JCM can facilitate specification of MOS incentive levels that could better target specific applicants.

JCM Estimation

Method

We estimated the JCM parameters using the maximum simulated likelihood method implemented in the BIOGEME software (Bierlaire, 2003). This method uses simulation to approximate the MMNL probability model above when evaluating the likelihood during estimation. Altogether, the estimation involved an 11-dimensional multivariate normal distribution for each applicant, 10 normal random variables $\xi_{i,c(m)}$ (*m*=1,…,10) for the MOS cluster error components and one variable, $\xi_{i,999}$, for the heteroscedastic utility specified for applicants facing multiple MOS alternatives. We used 200 hundred Halton draws (quasi random numbers) from this distribution for each applicant during estimation.

Estimation Data

Using the REQUEST data from FY 2010 Q1 and Q2, we estimated a common JCM for the two quarters combined. We estimated a common model instead of separate models by quarter for the following reasons. First, we only had about fifty percent of the REQUEST transactions for Q1. Second, unlike in the bonus cap study, monetary incentives were offered less frequently with a limited range; combining EIRB incentive levels from Q1 and Q2 increases the variance of the monetary incentives. Third, for forecasting application, one estimated JCM should be sufficient, because the estimation data will eventually be reweighted to have the same applicant distribution (i.e. gender, AFQT category, education status subgroups) as the target quarter. Combining Q1 and Q2 REQUEST data produces a larger estimation sample for each MOS and applicant subgroup than one quarter of data.

There were a total of 60,403 applicants in the FY 2010 Q1 and Q2 data after carrying out data checks and diagnostics to ensure consistency between job lists and reservation records. Of this total, 25,481 were classified as accessions (individuals with reservation) and the remaining 34,922 as non-accessions (individuals without reservation). Note that the non-accession rate was 57.8%, more than twice the non-accession rate of 27.7% in the bonus cap study. Because the total number of accessions appear consistent with prior FY data, we presume that the high percentage of applicants who did not make a reservation could be related to the new system in place, in which recruiters in the field can enter temporary reservations in addition to the usual reservations entered by counselors at the MEPS. We were not able to obtain additional information that could have been used to verify the relatively high non-accession percentage.

For this JCM estimation application, we adjusted the FY 2010 Q1 and Q2 data to obtain a non-accession rate that was more in line with previous FYs. The adjustment was carried out by taking a random sample of 10,000 from the 34,922 non-accessions in the REQUEST data, producing an adjusted total of 35,481 applicants, with 28.2% (n=10,000) non-accessions and 71.2% (n=25,481) accessions. From this adjusted REQUEST data, we obtained an estimation sample of 8,160 applicants of which 7,160 were accessions and 1,000 non-accessions. To ensure that all MOS-TOS combinations were adequately represented in the estimation, we used choice-based sampling to select the 7,160 accessions. This was carried out by grouping the applicants according to their chosen MOS and TOS, and then under-sampling the larger MOS-TOS groups and over-sampling the smaller MOS-TOS groups. During estimation, each applicant was weighted by the reciprocal of the sampling rate of his/her MOS-TOS group. The remaining 27,321 applicants (18,321 are accessions and 9,000 non-accessions) were used to form the hold-out sample for evaluating JCM prediction accuracy. The weight used for each applicant in the hold-out was equal to the reciprocal of the probability of his/her non-inclusion in the estimation sample.

Table 7. JCM Parameter Estimates Using 28% Non-Accession

Parameter	Estimate	S.E.	t-stat	Parameter	Estimate	S.E.	t-stat
MOS-Specific Constants				*MOS-Specific Constants (cont'd)*			
AM01	0			*AM49*	1.3974	0.2402	**5.82**
AM02	-1.7335	0.0937	**-18.5**	*AM50*	-0.4013	0.2975	-1.35
AM03	-2.4276	0.1145	**-21.2**	*AM51*	-0.4619	0.3154	-1.46
AM04	-1.3189	0.0725	**-18.19**	*AM52*	0.5930	0.2590	**2.29**
AM05	-3.8410	0.1902	**-20.19**	*AM53*	1.0574	0.2423	**4.36**
AM06	-3.1012	0.1745	**-17.77**	*AM54*	0.7591	0.2469	**3.07**
AM07	-2.7681	0.2049	**-13.51**	*AM55*	0.1697	0.4024	0.42
AM08	-1.8999	0.1284	**-14.8**	*AM999*	-2.4047	0.3530	**-6.81**
AM09	-2.2533	0.1158	**-19.46**				
AM10	1.7500	0.3737	**4.68**	*TOS-Specific Constants*			
AM11	2.2074	0.2946	**7.49**	*AT3*	0.0000		
AM12	0.4687	0.3937	1.19	*AT4*	-1.2999	0.0871	**-14.93**
AM13	2.6839	0.1689	**15.89**	*AT5*	-2.6388	0.1948	**-13.55**
AM14	0.4887	0.1163	**4.2**	*AT6*	-3.4881	0.1920	**-18.17**
AM15	-1.2679	0.1135	**-11.17**				
AM16	-0.8130	0.5390	-1.51	*MOS Cluster-Subgroup Interactions*			
AM17	-1.2308	0.5016	**-2.45**	*GM13A01*	0.0000		
AM18	-1.2618	0.4614	**-2.73**	*GM13A02*	-0.5867	0.1776	**-3.3**
AM19	1.1536	0.6049	1.91	*GM13A03*	-0.5496	0.3668	-1.5
AM20	3.3815	0.4811	**7.03**	*GM13A04*	-0.5668	0.1647	**-3.44**
AM21	0.3988	0.2835	1.41	*GM13A05*	0.2059	0.3203	0.64
AM22	-0.7188	0.2561	**-2.81**	*GM13A06*	-1.0355	0.1775	**-5.83**
AM23	0.6273	0.2658	**2.36**	*GM13A07*	0.0448	0.2083	0.21
AM24	-0.7019	0.2897	**-2.42**	*GM13A08*	-0.4954	0.4907	-1.01
AM27	-0.5119	0.6150	-0.83	*GM13A09*	-0.1459	0.3167	-0.46
AM28	-1.6488	0.3284	**-5.02**	*GM13A10*	-0.5443	0.3847	-1.41
AM29	-1.9774	0.3370	**-5.87**	*GM13A999*	2.8860	0.2871	**10.05**
AM30	0.8060	0.3966	**2.03**	*GMedC01*	0.0000		
AM31	3.9741	0.7060	**5.63**	*GMedC02*	0.5900	0.1860	**3.17**
AM32	-0.7696	0.4416	-1.74	*GMedC03*	0.2772	0.3485	0.8
AM33	1.3837	0.4304	**3.21**	*GMedC04*	0.2056	0.1991	1.03
AM34	-1.5028	0.3356	**-4.48**	*GMedC05*	0.3165	0.4021	0.79
AM35	-1.6851	0.3115	**-5.41**	*GMedC06*	0.6078	0.1916	**3.17**
AM36	-2.0759	0.3589	**-5.78**	*GMedC07*	0.1589	0.2265	0.7
AM37	-1.3497	0.3051	**-4.42**	*GMedC08*	0.5600	0.2565	**2.18**
AM38	-0.1256	0.2896	-0.43	*GMedC09*	0.6219	0.3480	1.79
AM39	0.7094	0.3821	1.86	*GMedC10*	0.0569	0.4587	0.12
AM40	0.7469	0.2609	**2.86**	*GMedC999*	2.9023	0.3413	**8.5**
AM41	-0.3866	0.2235	-1.73	*GMedS01*	0.0000		
AM42	-1.3267	0.6472	**-2.05**	*GMedS02*	-0.3515	0.1925	-1.83
AM43	0.5279	0.2651	**1.99**	*GMedS03*	0.1212	0.3613	0.34
AM44	4.5389	0.6828	**6.65**	*GMedS04*	-0.4710	0.1911	**-2.47**
AM45	2.8370	0.5151	**5.51**	*GMedS05*	-0.0452	0.3920	-0.12
AM46	3.5506	0.5854	**6.07**	*GMedS06*	-0.8768	0.2150	**-4.08**
AM47	-0.7426	0.2412	**-3.08**	*GMedS07*	-0.5568	0.2824	**-1.97**
AM48	0.1143	0.2291	0.5	*GMedS08*	-1.2610	0.2936	**-4.3**

Table 7: JCM Parameter Estimates Using 28% Non-Accession (cont'd)

Parameter	Estimate	S.E.	t-stat
MOS Cluster-Subgroup Interactions (cont'd)			
GMedS09	-1.3189	0.3650	**-3.61**
GMedS10	-0.6914	0.3554	-1.95
GMedS999	2.1003	0.3996	**5.26**
GMsex01	0.0000		
GMsex02	0.0000		
GMsex03	0.0583	0.3664	0.16
GMsex04	0.8631	0.1937	**4.46**
GMsex05	-1.6320	0.3976	**-4.1**
GMsex06	-0.7069	0.1875	**-3.77**
GMsex07	0.9654	0.2277	**4.24**
GMsex08	-1.5081	0.3846	**-3.92**
GMsex09	-0.7717	0.2884	**-2.68**
GMsex10	0.3284	0.3687	0.89
GMsex999	-0.8906	0.3100	**-2.87**
TOS-Subgroup Interactions			
GT13A3	0.0000		
GT13A4	1.1132	0.0770	**14.46**
GT13A5	1.5625	0.1586	**9.85**
GT13A6	1.6970	0.1718	**9.88**
GTedC3	0.0000		
GTedC4	0.3767	0.1132	**3.33**
GTedC5	0.4536	0.1727	**2.63**
GTedC6	0.0312	0.2120	0.15
GTedS3	0.0000		
GTedS4	0.5428	0.1083	**5.01**
GTedS5	0.2329	0.2025	1.15
GTedS6	0.8074	0.1939	**4.16**
GTsex3	0.0000		
GTsex4	-0.5161	0.0817	**-6.32**
GTsex5	-0.6707	0.1470	**-4.56**
GTsex6	-0.1208	0.1528	-0.79
MOS AA and Incentives			
Baa	1.3131	0.1469	**8.94**
Incentives Not Dependent on MOS Level			
Bhg	-0.2591	0.0556	**-4.66**
Brb	0.1938	0.0418	**4.64**
Bdeb	-0.3947	0.3768	-1.05

Parameter	Estimate	S.E.	t-stat
EB-Only Incentive			
BebC1	0.1781	0.0153	**11.62**
BebG1	0.1816	0.0104	**17.44**
BebS1	0.1184	0.0166	**7.13**
EB-ACF Incentive (College+)			
BalC3	1.5594	0.1127	**13.83**
BalC4	0.8291	0.1124	**7.38**
BalC5	0.1324	0.1814	0.73
BalC6	0.1712	0.2402	0.71
BebC2	0.2445	0.0356	**6.87**
EB-ACF Incentive (Senior)			
BalS3	0.9102	0.1272	**7.16**
BalS4	0.7987	0.1243	**6.43**
BalS5	-0.2803	0.3321	-0.84
BalS6	-0.2814	0.2614	-1.08
BebS2	0.0628	0.0596	1.05
EB-ACF Incentive (HSG)			
BalG3	0.7561	0.0570	**13.25**
BalG4	0.7011	0.0687	**10.2**
BalG5	-0.5428	0.1529	**-3.55**
BalG6	-0.3539	0.1505	**-2.35**
BebG2	0.1249	0.0320	**3.90**
S.D. of Error Components			
SF01	2.4911	0.2618	**9.51**
SF02	0.9364	0.3686	**2.54**
SF03	2.1074	0.6487	**3.25**
SF04	1.4743	0.2785	**5.29**
SF05	1.3185	0.3940	**3.35**
SF06	0.9439	0.3087	**3.06**
SF07	0.9611	0.9505	1.01
SF08	1.4466	0.4680	**3.09**
SF09	0.0616	0.8484	0.07
SF10	0.0250	0.3874	0.06
Multiple Opportunity SD			
SF999	6.1654	0.4621	**13.34**

Estimation Results

Estimating the parameters of the JCM was computationally intensive given the large sample size and number of utility equations. Overall, there are a total of 457 utility equations for the three-dimensional choice problem (although less than 300 alternatives are available for any applicant), compared to the 137 total in the bonus cap study. We ran Biogeme's MMNL estimation method using the JCM specification described earlier until convergence. The estimated JCM parameters and their corresponding standard errors (S.E.) and t-statistics are shown in Table 7. These standard errors and t-statistics are based on robust variance-covariance matrix estimates (Bierlaire, 2003). Bolded t-statistics are significant at the .05 level. Where standard error and t-statistic values are blank, the corresponding parameters were fixed at zero.

Interpreting the JCM Parameters

Direct interpretation of the JCM parameters is not straightforward. Ultimately, applicant preferences relate to the JCM parameters through the differences in systematic utilities of enlistment alternatives. Interpretation is also made complicated by the interactions between MOS and TOS alternatives and applicant demographics, as well as with unobserved applicant characteristics underlying the error components. The following discussion focuses on the JCM parameters that describe the relative preferences of applicants in relation to the EB/ACF/LRP incentive levels.

MOS and TOS

We first describe the MOS and TOS constants that characterize the average relative preferences of applicants for different enlistment alternatives. The estimated values for the MOS constants correspond to the parameters prefixed by "AM" in Table 7. Note that these constants are expressed as differences relative to MOS 11X, which was fixed at zero. The estimated values for MOS alternative-specific constants ranged from about -3.8 to 4.5. The middle 50 percent of MOS constants ranged from -1.33 to 0.76, while the middle 80 percent ranged from -2.05 to 2.60. As discussed below, these differences between estimated MOS alternative constants were within the range of the direct effects of the EB/ACF incentives. The estimated values for the TOS constants correspond to the parameters prefixed by "AT" in Table 7. The TOS constants were normalized relative to TOS = 3, which was fixed at zero. The estimated constants were negative and decreasing from TOS = 4 to TOS = 6, indicating lower overall preferences for longer TOS for given MOS and incentive. The average systematic utilities for TOS = 4, 5, and 6 decreased by 1.30, 2.64, and 3.49, respectively, when compared to TOS = 3. As with differences in MOS preferences, the average relative preferences across TOS were also within the range of the effects of EB/ACF incentives and could be "managed" by the application of these incentives.

EB and ACF Incentives

Next, we describe parameters that capture the effects of EB/ACF/LRP incentives on applicant enlistment preferences. Recall that in specifying the JCM, we separately measured the effects of EB-only and EB+ACF types of incentives, along with their interaction with education status. This specification was based on a preliminary analysis of the distribution of a chosen type of incentive and education status (see Table 4). In the following discussion we illustrate the potential of the full EB incentive for managing the preferences of applicants with at least some college education, using a numerical example.

The estimated coefficients for the full EB incentive for applicants with at least some college education is given by *BebC1* = 0.1781 in Table 7, representing a change of 0.1781 in utility for every thousand in EB incentive. This estimated coefficient is highly statistically significant (t-stat=11.62), with a magnitude that can meaningfully increase/decrease applicants' preferences for MOS-TOS enlistment alternatives. To demonstrate the potential of the full EB incentive to manage MOS preferences of applicants with some college education, we calculated the change in systematic utility obtained by raising the EB incentive to level 1 from each of the lower levels in Q1 of FY 2010. Table 8 summarizes resulting increases in systematic utility by incentive level and TOS. The column "Amt" shows the amount of enlistment bonus for each level in thousands, while the column "Util Diff" shows the increase in systematic utility if the bonus is raised to level 1. Changes in systematic utility were computed by multiplying the difference in bonus amount between incentive levels by 0.1781. As can be seen in Table 8, raising the EB dollar amount from level 3 or lower to level 1 produces substantial increases in systematic utility relative to differences in MOS constants. In other words, the differences in average MOS preferences are within the range of the effects of the EB incentives, especially for higher TOS.

Table 8. Change in Systematic Utility by Raising Enlistment Bonus Incentives to Level 1 from Lower Levels (2, 3, 4, None) Using FY 2010 Q1 Incentive Levels

	TOS=3		TOS=4		TOS=5		TOS=6	
Level	**Amt**	**Util Diff**	**Amt**	**Util Diff**	**Amt**	**Util Diff**	**Amt**	**Util Diff**
1	7	*0.00*	10	*0.00*	15	*0.00*	20	*0.00*
2	4	*0.53*	7	*0.53*	10	*0.89*	15	*0.89*
3	2	*0.89*	3	*1.25*	6	*1.60*	8	*2.14*
4	0	*1.25*	1	*1.60*	3	*2.14*	6	*2.49*
None	0	*1.25*	0	*1.78*	0	*2.67*	0	*3.56*

We also demonstrate the potential of the full EB incentive for managing preferences of applicants with at least some college education across TOS. Table 9 shows the differences in average preferences for each of the higher TOS (4, 5, and 6) compared to TOS = 3, taking into account the effects of EB at each level. For each row (incentive level), the differences in average systematic utility across TOS are given under the column "Util Diff". Note that differences shown along the first row, which corresponds to no incentive (Level = None), are simply the estimated TOS constants. The remaining rows show differences in average preferences between each of the higher TOS and TOS = 3 for incentive levels 1 through 4, after adjusting for the effect of the amount of bonus at the given incentive level (row). Adjustments were computed by multiplying the differences in bonus amounts between the higher TOS and TOS = 3 for the given incentive level by *BebC1* = 0.1781.

Table 9 shows that bonuses can substantially increase the overall preference for higher TOS. For example, the average preferences for TOS=5 and 6 are lower than the preference for TOS = 3 by 2.64 and 3.49, respectively, when no incentives are offered. However, average preference for TOS = 5 and 6 are lower than preference for TOS = 3 only by 1.21 and 1.17, respectively, under incentive level 1, and by 1.57 and 1.53, respectively, under incentive level 2. The corresponding improvement in relative preferences for TOS = 5 and 6 over TOS = 3 are 1.42 and 2.31 under level 1, and 1.07 and 1.96 under level 2. These improvements are substantial when compared to the standard deviation of the difference in the utilities of any two enlistment alternatives, which is equal to 1.81.[5]

Table 9. Differences in Average Systematic Utility Across TOS Adjusted for Effects of Enlistment Bonus by Incentive Level for FY 2010 Q1

	TOS=3		**TOS=4**		**TOS=5**		**TOS=6**	
Level	**Amt**	**Util Diff**	**Amt**	**Util Diff**	**Amt**	**Util Diff**	**Amt**	**Util Diff**
None	0	*0.00*	0	*-1.30*	0	*-2.64*	0	*-3.49*
1	7	*0.00*	10	*-0.77*	15	*-1.21*	20	*-1.17*
2	4	*0.00*	7	*-0.77*	10	*-1.57*	15	*-1.53*
3	2	*0.00*	3	*-1.12*	6	*-1.93*	8	*-2.42*
4	0	*0.00*	1	*-1.12*	3	*-2.10*	6	*-2.42*

The preceding discussion demonstrated the potential of the full EB incentive for managing the preferences of applicants with at least some college education. The full EB incentive has a comparable effect on the preferences of high school graduates with an estimated coefficient of *BebG1*=0.1816. The effect of full EB on preferences of senior applicants is somewhat lower but still strong, with an estimated coefficient of *BebS1*=0.1184.

While the contribution of the full EB on the systematic utility of each education status subgroup is determined entirely by the coefficients *BebC1*, *BebG1*, and *BebS1*, the contribution of the reduced EB incentive package (EB+ACF/LRP) is determined by a reduced bonus coefficient and an ACF/LRP TOS-specific constant. In Table 7, the reduced bonus coefficients correspond to parameters *BebC2*, *BebG2*, and *BebS2*, while the constants correspond to parameters with prefix "*Bal*" and suffix indicating the TOS. The contribution of the reduced EB package on applicant preferences is calculated as follows. Using Q1 FY 2010 incentives, the contribution of the reduced EB package on the systematic utility of an applicant with some college education for an MOS with incentive level 2 and TOS=4 is BalC4 + BebC2×4 = 0.8291 + 0.2445×4 = 1.8071, while the contribution of the full EB package is: BebC1×7 = 0.1781×7 = 1.2467.

Figure 1 graphically summarizes the average effects of full EB and reduced EB+ACF/LRP incentive packages on the preferences of applicants in Q1 of FY 2010, separately by education status. The solid lines trace the contribution of the full EB incentive across TOS by MOS level, while the dash lines trace the contribution of the reduced EB+ACF/LRP incentives. Figure 2 provides the same information using incentives in Q2 of FY 2010. Note that the effects

[5] This is computed as the square root of two times $\pi^2/6$, the variance of the unobserved utility $E_{i,m,t,k}$.

of EB+ACF incentives at levels 3, 4 and 5 are overlapping, as all three levels have zero reduced EB. The following discussion highlights important observations regarding the effect of EB/ACF/LRP incentives on applicant preferences.

Most evident from examination of Figures 1 and 2 is that the effects of incentives on preferences across TOS differ by type of incentive package (full EB or EB+ACF/LRP). Also, the way the effects differ between incentive packages depends on education status. The overall pattern suggests that the reduced EB+ACF package has relatively more value to applicants with at least some college education than to high school graduates and senior applicants. For instance, at TOS = 3, the contributions of reduced EB+ACF packages to the systematic utility of applicants with some college education at levels 1, 2, and 3 are all substantially greater than those for the corresponding full EB package. This is not surprising as these applicants are more likely to benefit highly from the ACF/LRP component of the incentive package alone, whether to pay for existing loans or to complete college education. The low enlistment bonuses at TOS = 3 would not be as valuable for these applicants. For high school seniors and graduates, the contributions of the full EB and EB+ACF/LRP on applicant preferences at TOS = 3 differ negligibly at levels 1, 2 and 3.

At higher TOS (5 or 6), the effect of the full EB package on applicant preferences is consistently higher than that for the reduced EB+ACF/LRP package across education status groups. Note, however, that the reduced EB+ACF/LRP package retained its value for applicants with some college education, but not for seniors and high school graduates. The difference between the two types of incentive package at levels 1 and 2 suggests that high school graduates and, somewhat to a lesser extent, seniors enlisting for higher TOS (5 and 6) do not have any use for ACF and are mainly interested in the full bonus. All these patterns are consistent with the interaction observed earlier in Table 4 between the type of chosen incentive and the education status of applicants.

Figure 1. EB/ACF Effects by Incentive Level for FY 2010 Q1[6]

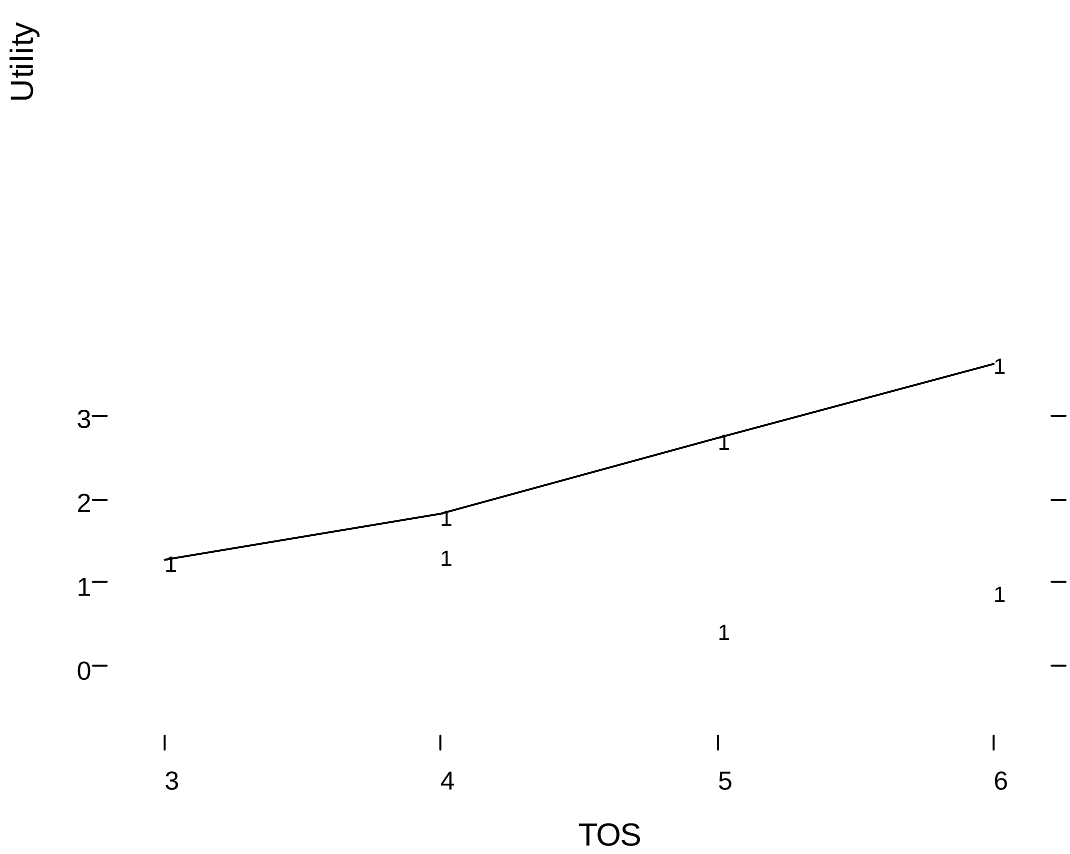
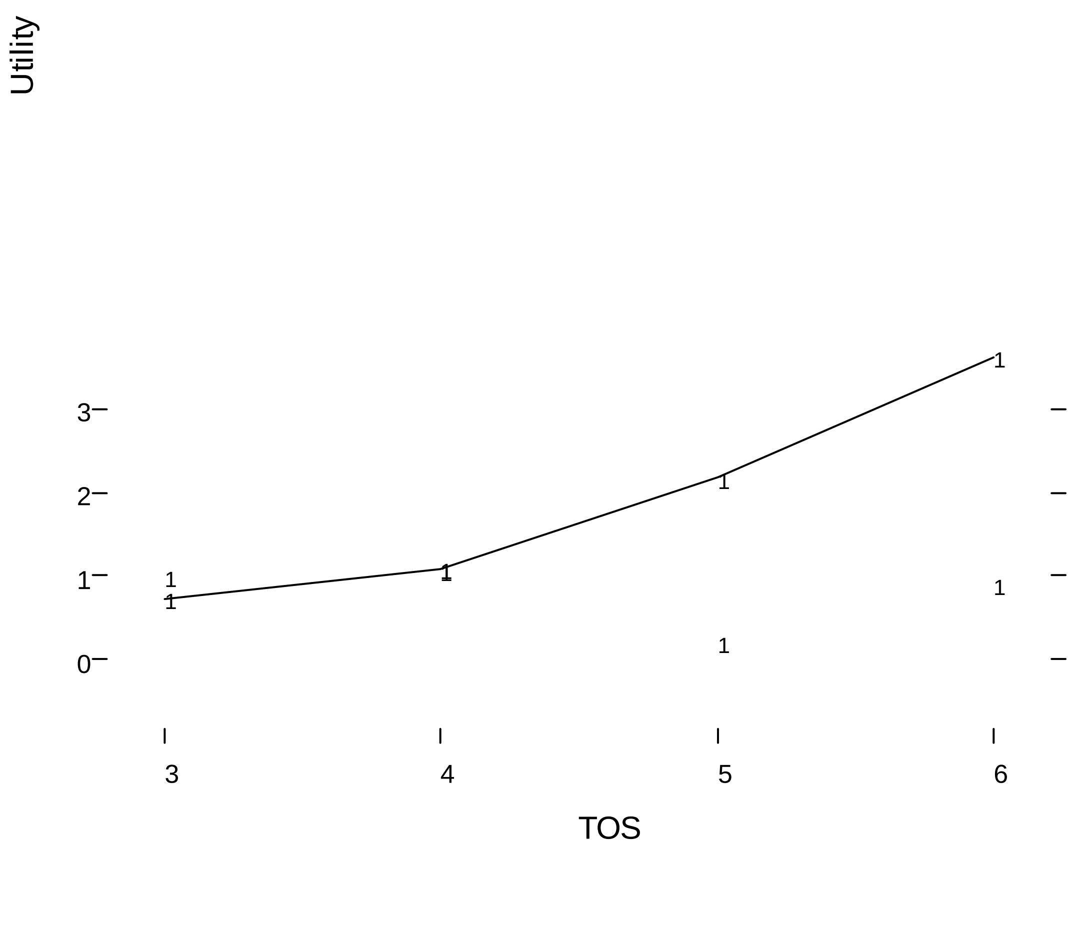


***Figure 2. EB/ACF Effects by Incentive Level for FY 2010 Q2*[7]**



Note that effects of full EB and reduced EB+ACF/LRP packages at each incentive level do not match closely across TOS, especially at TOS = 5 and 6 for seniors and high school graduates. This does not mean, however, that the levels of incentives are inconsistent. For a given TOS, we expect a utility maximizing applicant to choose the type of incentive that has more value to him/her. Therefore, comparison between incentive levels will be based on the higher value between the full EB and reduced EB+ACF/LRP effects for a given TOS.

Figures 1 and 2 also summarize the potential of the EB/ACF/LRP incentives to channel enlistment to higher incentivized MOS and longer TOS. Larger differences between lines indicate greater potential for channeling enlistments from MOS with lower incentives to MOS with higher incentives. Steeper slopes indicate greater potential for channeling enlistment from shorter to longer TOS. These channeling effects depend on the amounts of incentive and their differences across incentive levels and TOS. For example, in Q2 FY 2010, level 1 incentives were decreased to 4K, 6K and 12K dollars, respectively, for TOS = 3, 4, and 5 from the corresponding amounts in Q1, which were 7K, 10K, and 15K dollars, while the incentive for TOS = 6 remained at 20K. Amounts of incentives for levels 2 and lower were decreased correspondingly (see Table 6). Comparing the charts for applicants with college education, we observe that levels 2 and 3 in Figure 2 do not differ as much as they do in Figure 1. This means that raising the incentive to level 2 would not have been as effective at increasing the likelihood of enlistment for an MOS at TOS = 5 in Q2 FY 2010 as it would have in Q1 FY 2010. To achieve the same effect, it would have been necessary to raise the incentive to level 1 in Q2 FY 2010.

In sum, the EB/ACF/LRP incentives can be effective in managing applicant preferences for MOS-TOS enlistment alternatives. The estimated effects of the incentives differ across education status of applicants. Such information could be used to configure levels of incentives in combination with applicant supply forecast by education status. Estimated channeling effects of the EB/ACF/LRP incentives depend on the amounts of and differences in incentives across incentive levels and TOS. While most of the observations above are "well known" or "expected," the JCM provides a way for quantifying the effects objectively.

In addition to EB/ACF/LRP incentives, the JCM also included monetary incentives that were not tied to the incentive level of an MOS and TOS. We briefly describe their estimated effects on applicant preferences. The High Grad (HG) bonus is available to applicants with college education for incentivized MOS (levels 1 to 5) with dollar amounts that vary by number of college credit hours. As such, the HG bonus is not expected to channel applicants across MOS or TOS. From Table 7, the estimated coefficient for HG bonus is -0.2591, which is statistically significant. We do not have a clear explanation regarding the sign of the coefficient. Because it is available to incentivized MOS, HG can only differentiate between incentivized MOS on the one hand, and non-incentivized MOS or non-accession on the other hand. It is likely that the HG incentive has a positive effect on recruiting (or getting applicants to the MEPS), which the JCM does not capture.[8] In any case, since the HG bonus is constant for incentivized MOS for a given applicant, it will not impact the channeling effect of EB/ACF/LRP across MOS and TOS.

Ranger Bonus (RB) is another incentive that is available to some MOS as determined by REQUEST. The estimated coefficient for RB is 0.1938, which is statistically significant. Since it is generally available for only a few MOS, the amount of RB can impact the channeling effects of EB/ACF/LRP incentives. For example, it will take higher amounts of EB to increase the preference for a non-RB eligible MOS over an RB eligible MOS.

The last monetary incentive is the deferred enlistment bonus (DEB), which is available only to seniors and is a function of the number of months from contract date to reception date. Like the HG bonus, it is not expected to impact channeling effects of the EB/ACF/LRP incentives. Its estimated coefficient is -0.3947, which is not significant.

Applicant Characteristics

We also describe the interaction between applicant characteristics and their preferences for MOS and TOS enlistment alternatives. We begin by discussing how the aptitude area (AA) profile of applicants impacts the channeling effects of the EB/ACF/LRP incentives. The JCM parameter that relates the AA profile of applicants to their MOS preference is *Baa*, which is multiplied by the AA score for an MOS. The *Baa* coefficient therefore captures the difference in the preferences of an applicant for two MOS, based on the difference between the corresponding AA scores. From Table 7, this coefficient is estimated to be 1.3131, which is strongly statistically significant. This estimate indicates that applicants tend to prefer MOS for which they have higher aptitude. In particular, because the AA scores were rescaled with a mean of zero and a standard deviation of one, every standard deviation unit in the difference between two MOS alternatives would account for a difference of 1.3131 in their systematic utilities. This observed person-job match is consistent with that observed in previous work modeling Army applicants' job choices (Diaz et al., 2007b). It has a neutral effect on the channeling potential of the EB/ACF/LRP incentives. In particular, we would expect that increasing enlistments for an MOS with few high aptitude applicants will require a higher bonus compared to the bonus needed to increase enlistments for an MOS with more high aptitude applicants. Note that the estimated effect of *Baa* = 1.3131 on the preferences of applicants with some college education whose AA scores on two MOS differ by 20 points (i.e., 1 SD) is equal to the channeling effect expected from a 7K difference in full bonuses between the two MOS. Looking at Table 8, this would be equivalent to raising the incentive level from 4 to 1 at TOS = 3, or from level 3 to 1 at TOS = 4.

In addition to the differences in AA profiles, the JCM also modeled the interaction between applicant demographics and their MOS and TOS preferences. The estimated interaction constants correspond to parameters prefixed by "GM" (for MOS) and "GT" (for TOS) in Table 7. For interpretation purposes, it is helpful to view these estimated interactions as "adjustments" in the relative preferences for MOS and TOS alternatives of a given demographic group. In

[8] In the bonus cap study, the corresponding coefficient was significantly positive. But the data in that study included substantial amounts of seasonal bonuses and employed a different EB/ACF/LRP specification. So it is difficult to directly compare the coefficients.

particular, to obtain the adjusted relative MOS preferences for AFQT Category I-IIIA applicants, we would add the interactions prefixed by "GM13A" to the corresponding MOS constants. Large differences between estimated interaction constants mean that relative preferences for MOS and TOS (i.e., differences in their systematic utilities) will differ substantially from one subgroup to another. Below, we highlight interactions that stand out based on this interpretation.

The MOS and demographic subgroup interactions correspond to the "GM" parameters in Table 7 with suffix indicating the subgroup and reduced MOS cluster. The estimated effects for AFQT category and MOS cluster interaction indicate that Category I-IIIA applicants are less likely to join the Army than Category IIIB and IV applicants; based on the estimate for *GM13A999*, systematic utility for not-joining the Army is 2.8860 higher for I-IIIA applicants. Between MOS, the estimated interactions are somewhat small. Only one of the three statistically significant estimated interaction effects (*GM13A06* = -1.0355) can be considered high relative to differences between MOS constants, implying that I-IIIA applicants are less likely to prefer the logistics/supply support type of MOS.

The estimated interaction effects for education status and MOS cluster, which are prefixed by "GMedC" and "GMedS", indicate that applicants with some college education and seniors are less likely to join the Army compared to high school graduates. Between MOS, the estimated interactions for applicants with college education are somewhat small (regardless of statistical significance). For seniors, the interaction effect for reduced MOS clusters eight and nine are relatively large compared to MOS constants. The estimated effects *GMedS08* = -1.2610 and *GMedS09* = -1.3189 suggest that seniors are less likely to prefer medical care and skilled science types of MOS.

The estimated interaction effects for gender and MOS cluster, which are prefixed by "GMgender" or "GMsex", indicate males are more likely to join the Army compared to females. Between MOS, the estimated interactions for gender are somewhat stronger compared to interactions for AFQT category and education status. In particular, the estimated interaction for reduced MOS clusters five and eight (*GMsexS05* = -1.6320, *GMsexS08* = -1.5081) are relatively high compared to MOS constants, suggesting that males are less likely to prefer administration and medical care types of MOS.

The estimated TOS and demographic subgroup interactions correspond to the "GT" parameters with suffix indicating the subgroup and TOS. The interaction effects for AFQT category are somewhat high compared to the TOS constants, with estimates indicating that I-IIIA applicants are more likely to enlist for longer TOS (5 and 6) compared to IIIB applicants (*GT13A5*=1.5625, *GT13A6*=1.6970). The estimated TOS interaction effects for both education status and gender subgroups, which are prefixed by "GTedC", "GTedS", and "GTsex", are generally small compared to the TOS constants (regardless of statistical significance). Unlike the estimated AFQT-TOS interaction, there are no strong indications that applicants with some college or seniors prefer longer/shorter TOS compared to high school graduates, or that males prefer longer/shorter TOS.

Finally, we briefly describe the estimated standard deviation (SD) of error components related to unobserved applicant characteristics. Overall, the estimated SD of the error components indicate that enlistment alternatives have unequal variance (heteroscedasticity) across reduced MOS clusters and are inter-correlated within clusters. Seven of the nine error components have statistically significant estimated SD, with magnitudes that are comparable to those obtained in the bonus cap study. Lastly, the extra variance included in the non-accession utility of applicants with more than one MOS in their REQUEST list is also significant. This means that the variance of the difference between the utility for not joining the Army and the utilities for MOS alternatives is larger for applicants with multiple MOS compared to those with a single MOS in their REQUEST list.

Model Fit Diagnostics

The estimated JCM has a pseudo R-squared of 0.28, which is substantial given the dimension of the choice space. This is slightly higher than the pseudo-R2 in the bonus cap study. It is not simple to compare the two estimated JCMs because of differences in dimension of the choice space, specification of the EB/ACF/LRP components, and the levels and variance of incentives (greater variance in the bonus cap study). In any case, the specification of the EB/ACF/LRP in the present JCM represents an improvement over that in the bonus cap study, with coefficients that are very meaningful, as described in the above discussion.

To further evaluate model fit, we compared the expected choices of applicants based on the estimated JCM to their actual choices. This comparison was conducted separately using the JCM estimation sample (n = 8,160) and the hold-out validation sample (n = 27,321). Comparisons were only carried out on the MOS alternative dimension and only for the overall sample. Table 10 shows the results for the estimation sample while Table 11 shows the results for the hold-out sample. Each row in these tables compares the observed and expected number of accessions and the corresponding percentage for each MOS. The column “Diff. N” reports the difference between observed and expected number of accessions, while the column “Ratio N” reports the ratio of expected accessions relative to observed accessions. In addition to MOS fills, the table also reports the observed and expected amount of enlistment bonus (“Obs. EB” and “Exp. EB”) for each MOS. “Observed bonus” is simply the average amount of EB computed across applicants who chose the MOS for the given row. The “expected bonus” for each MOS was computed as a weighted average across all applicants (whether or not they chose the MOS), using the JCM probabilities as weights.

As evidenced by Tables 10, the estimated number of accessions/non-accessions closely matched the observed accessions/non-accessions for most MOS alternatives in the estimation sample. This is to be expected for the estimation sample, especially with a JCM that includes MOS-specific constants. The few MOS alternatives with somewhat sizeable differences tended to have a small number of accessions. As with the estimation sample, there was a strong correspondence between the observed and expected number of accessions/non-accessions for most MOS in the hold-out sample. Similarly, relatively large differences tended to occur for MOS with small numbers of accessions. Overall our fit diagnostics indicated that the internal fit and predictive accuracy of the JCM was very good.

Table 10. Estimation Sample: JCM Fit Diagnostics by MOS Alternative

Alt. ID	MOS	Obs. N	Exp. N	Diff. N	Ratio N	Obs. Pct.	Exp. Pct.	Obs. EB	Exp. EB
1	11X1	5467	5595.5	-129.0	1.02	15.421	15.785	0.86	0.56
2	13F1	526	527.9	-1.9	1.00	1.484	1.489	0.94	0.68
3	FA11	350	349.2	0.8	1.00	0.987	0.985	3.11	3.28
4	FA12	931	946.7	-15.7	1.02	2.626	2.671	0.00	0.00
5	FA21	46	47.0	-1.0	1.02	0.130	0.133	1.36	1.41
6	FA22	99	103.3	-4.3	1.04	0.279	0.292	0.62	0.36
7	FA23	52	51.6	0.4	0.99	0.147	0.145	0.00	0.00
8	AD11	569	562.6	6.4	0.99	1.605	1.587	8.64	8.87
9	AD12	443	454.2	-11.2	1.03	1.250	1.281	0.25	0.20
10	AV11	59	58.3	0.7	0.99	0.166	0.164	3.80	3.16
11	AV12	731	712.3	18.7	0.97	2.062	2.009	0.00	0.00
12	AV21	56	51.7	4.3	0.92	0.158	0.146	0.00	0.00
13	18X1	377	333.0	44.0	0.88	1.064	0.940	1.47	2.30
14	19D1	551	564.3	-13.3	1.02	1.554	1.592	0.00	0.00
15	19K1	374	371.9	2.1	0.99	1.055	1.049	0.27	0.26
16	EN11	72	66.8	5.2	0.93	0.203	0.188	0.35	0.63
17	EN12	824	830.3	-6.3	1.01	2.325	2.342	0.00	0.00
18	EN21	722	709.5	12.5	0.98	2.037	2.002	0.00	0.00
19	SI11	23	23.9	-0.9	1.04	0.065	0.067	2.80	4.09
20	SI12	191	190.3	0.7	1.00	0.539	0.537	0.00	0.00
21	SI21	232	254.2	-22.2	1.10	0.654	0.717	11.19	11.02
22	SI22	910	990.6	-80.6	1.09	2.567	2.795	3.70	3.35
23	SI23	430	468.3	-38.3	1.09	1.213	1.321	0.73	1.19
24	SI24	261	247.5	13.5	0.95	0.736	0.698	0.00	0.00
27	LE11	434	415.9	18.1	0.96	1.224	1.173	0.00	0.00
28	EL11	264	301.5	-37.5	1.14	0.745	0.851	1.48	1.13
29	EL12	178	170.5	7.5	0.96	0.502	0.481	0.00	0.00
30	EL21	36	32.8	3.2	0.91	0.102	0.093	0.00	0.00
31	AX11	128	125.0	3.0	0.98	0.361	0.353	1.54	0.98
32	AX12	93	85.7	7.3	0.92	0.262	0.242	0.17	0.12
33	AX13	301	291.2	9.8	0.97	0.849	0.822	0.00	0.00
34	AM11	155	139.3	15.7	0.90	0.437	0.393	0.00	0.00
35	52D1	541	556.4	-15.4	1.03	1.526	1.570	0.16	0.13
36	VM11	51	44.0	7.0	0.86	0.144	0.124	0.14	0.04
37	VM12	421	447.4	-26.4	1.06	1.188	1.262	0.00	0.00
38	VM21	753	781.4	-28.4	1.04	2.124	2.204	0.00	0.00
39	74D1	299	289.5	9.5	0.97	0.843	0.817	0.00	0.00
40	TR11	223	223.9	-0.9	1.00	0.629	0.632	0.00	0.00

Table 10. Estimation Sample: JCM Fit Diagnostics by MOS Alternative (cont'd)

Alt. ID	MOS	Obs. N	Exp. N	Diff. N	Ratio N	Obs. Pct.	Exp. Pct.	Obs. EB	Exp. EB
41	88M1	1088	1071.1	16.9	0.98	3.069	3.022	0.18	0.12
42	89D1	367	405.2	-38.2	1.10	1.035	1.143	11.02	12.94
43	89B1	154	147.3	6.7	0.96	0.434	0.416	0.00	0.00
44	MD11	36	40.0	-4.0	1.11	0.102	0.113	1.33	1.86
45	MD12	207	192.0	15.0	0.93	0.584	0.542	0.00	0.00
46	MD13	1354	1293.2	60.8	0.96	3.820	3.648	0.00	0.00
47	92F1	464	494.0	-30.0	1.06	1.309	1.394	0.23	0.11
48	92G1	833	811.2	21.8	0.97	2.350	2.288	0.00	0.00
49	SL11	1283	1221.3	61.7	0.95	3.619	3.445	0.00	0.00
50	IN11	303	279.7	23.3	0.92	0.855	0.789	12.48	16.17
51	IN12	52	50.3	1.7	0.97	0.147	0.142	2.02	2.33
52	IN13	224	222.5	1.5	0.99	0.632	0.628	0.54	0.40
53	IN14	600	611.5	-11.5	1.02	1.693	1.725	0.04	0.02
54	HI11	273	266.4	6.6	0.98	0.770	0.751	0.00	0.00
55	15W1	37	40.9	-3.9	1.10	0.104	0.115	0.99	0.28
999	NACC	10000	9885.3	114.7	0.99	28.210	27.887	0.00	0.00

Note to this and following table: Each row compares the observed and expected number of accessions and the corresponding percentage for each MOS. The column "Diff. N" reports the difference between observed and expected number of accessions, while the column "Ratio N" reports the ratio of expected accessions relative to observed accessions. The table also reports the observed and expected amount of enlistment bonus ("Obs. EB" and "Exp. EB") for each MOS. "Observed bonus" is simply the average amount of EB computed across applicants who chose the MOS for the given row. The "expected bonus" for each MOS was computed as a weighted average across all applicants (whether or not they chose the MOS), using the JCM probabilities as weights.

Table 11. Hold-Out (Validation) Sample: JCM Fit Diagnostics by MOS Alternative

Alt. ID	MOS	Obs. N	Exp. N	Diff. N	Ratio N	Obs. Pct.	Exp. Pct.	Obs. EB	Exp. EB
1	11X1	5460	5550.4	-90.6	1.02	15.405	15.661	0.82	0.57
2	13F1	526	523.9	2.1	1.00	1.484	1.478	0.92	0.68
3	FA11	350	354.6	-4.6	1.01	0.988	1.000	3.02	3.20
4	FA12	932	974.3	-42.3	1.05	2.630	2.749	0.00	0.00
5	FA21	46	49.3	-3.3	1.07	0.130	0.139	2.18	1.63
6	FA22	99	99.9	-0.9	1.01	0.279	0.282	0.49	0.38
7	FA23	52	52.3	-0.3	1.00	0.147	0.147	0.00	0.00
8	AD11	569	546.9	22.1	0.96	1.605	1.543	8.98	8.79
9	AD12	443	449.0	-6.0	1.01	1.250	1.267	0.27	0.20
10	AV11	59	61.5	-2.5	1.04	0.166	0.173	2.69	3.16
11	AV12	731	741.8	-10.8	1.01	2.063	2.093	0.00	0.00
12	AV21	56	49.5	6.5	0.88	0.158	0.140	0.00	0.00
13	18X1	377	340.3	36.7	0.90	1.064	0.960	1.40	2.37
14	19D1	551	550.4	0.6	1.00	1.555	1.553	0.00	0.00
15	19K1	374	393.6	-19.6	1.05	1.055	1.110	0.23	0.26
16	EN11	72	61.9	10.1	0.86	0.203	0.175	0.25	0.58
17	EN12	824	807.9	16.1	0.98	2.325	2.280	0.00	0.00
18	EN21	722	712.8	9.2	0.99	2.037	2.011	0.00	0.00
19	SI11	23	18.5	4.5	0.80	0.065	0.052	4.87	4.06
20	SI12	191	198.0	-7.0	1.04	0.539	0.559	0.00	0.00
21	SI21	232	250.2	-18.2	1.08	0.655	0.706	10.49	10.91
22	SI22	910	986.7	-76.7	1.08	2.568	2.784	3.64	3.28
23	SI23	430	464.3	-34.3	1.08	1.213	1.310	0.70	1.16
24	SI24	261	253.5	7.5	0.97	0.736	0.715	0.00	0.00
27	LE11	434	399.9	34.1	0.92	1.225	1.128	0.00	0.00
28	EL11	264	310.8	-46.8	1.18	0.745	0.877	1.63	1.10
29	EL12	178	149.6	28.4	0.84	0.502	0.422	0.00	0.00
30	EL21	36	45.3	-9.3	1.26	0.102	0.128	0.00	0.00
31	AX11	128	128.1	-0.1	1.00	0.361	0.361	1.54	1.14
32	AX12	93	97.4	-4.4	1.05	0.262	0.275	0.09	0.11
33	AX13	301	288.2	12.8	0.96	0.849	0.813	0.00	0.00
34	AM11	155	142.2	12.8	0.92	0.437	0.401	0.00	0.00
35	52D1	541	534.1	6.9	0.99	1.526	1.507	0.11	0.13
36	VM11	51	41.1	9.9	0.81	0.144	0.116	0.00	0.02
37	VM12	421	445.7	-24.7	1.06	1.188	1.257	0.00	0.00
38	VM21	753	831.3	-78.3	1.10	2.125	2.345	0.00	0.00
39	74D1	299	289.2	9.8	0.97	0.844	0.816	0.00	0.00
40	TR11	223	219.5	3.5	0.98	0.629	0.619	0.00	0.00

Table 11. Hold-Out (Validation) Sample: JCM Fit Diagnostics by MOS Alternative (cont'd)

Alt. ID	MOS	Obs. N	Exp. N	Diff. N	Ratio N	Obs. Pct.	Exp. Pct.	Obs. EB	Exp. EB
41	88M1	1088	1034.8	53.2	0.95	3.070	2.920	0.16	0.11
42	89D1	367	401.0	-34.0	1.09	1.035	1.131	11.16	12.94
43	89B1	154	143.2	10.8	0.93	0.435	0.404	0.00	0.00
44	MD11	36	46.9	-10.9	1.30	0.102	0.132	1.36	1.79
45	MD12	207	207.7	-0.7	1.00	0.584	0.586	0.00	0.00
46	MD13	1354	1329.4	24.6	0.98	3.820	3.751	0.00	0.00
47	92F1	464	442.6	21.4	0.95	1.309	1.249	0.24	0.12
48	92G1	833	838.5	-5.5	1.01	2.350	2.366	0.00	0.00
49	SL11	1283	1275.8	7.2	0.99	3.620	3.600	0.00	0.00
50	IN11	303	283.6	19.4	0.94	0.855	0.800	12.76	16.25
51	IN12	52	48.3	3.7	0.93	0.147	0.136	2.61	2.75
52	IN13	224	235.9	-11.9	1.05	0.632	0.666	0.48	0.38
53	IN14	600	672.0	-72.0	1.12	1.693	1.896	0.01	0.02
54	HI11	273	245.6	27.4	0.90	0.770	0.693	0.00	0.00
55	15W1	37	44.1	-7.1	1.19	0.104	0.124	1.74	0.26
999	NACC	10000	9779.0	221.0	0.98	28.215	27.592	0.00	0.00

Proof-of-Concept Decision Support Tool (DST)

We developed a proof-of-concept DST to demonstrate the feasibility of assisting the EIRB using JCM policy simulation analysis. The DST's user interface and reporting functionalities were developed using Microsoft Excel and Visual Basic for Application, while the JCM simulation capability used components from the Biogeme software. In the following discussion we give an overview of how the DST works and then present two illustrative policy analysis examples that were carried out using the tool.

Overview

The EIRB's EB/ACF incentive policy is represented by two tables in the MILPER message. The first table specifies the dollar amounts for each of five incentive levels across TOS. For example, Table 6 shows the dollar values by level and type of incentive in Q1 and Q2 of FY 2010. The second table specifies the incentive level and minimum TOS to be eligible for the incentive by MOS. For example, Table 12 shows the levels and minimum TOS for each MOS in Q1 of FY 2010. The DST allows the user to specify these inputs to define an incentive policy scenario using the interface dialogs shown in Figures 3 and 4. Once these are defined, the user can run a simulation to assess the channeling effects of the incentive policy across MOS and TOS. The steps below summarize the procedure used by the proof-of-concept DST in carrying out a given incentive policy simulation.

(1) *Construct the simulated applicant transaction data based on the weighted FY 2010 estimation data.* The simulated data retained the enlistment alternatives and non-EB/ACF/LRP incentives in the original estimation data, while the EB/ACF/LRP incentives were zeroed out. These data serve as the starting point for each of the four policy simulation analyses.

(2) *Generate the simulated transaction data under a given incentive policy scenario.* The full EB, reduced EB, ACF, and LRP are computed for each enlistment alternative based on applicant's eligibility and MOS incentive level under a given incentive policy decision. This step completely initializes all incentive variables in the JCM.

(3) *Apply the JCM to obtain expected MOS-TOS accessions under a given policy scenario.* Using the estimated JCM, choice probabilities are computed for each applicant based on the incentives specified in step (2). Expected accessions are obtained by computing the weighted sum of the choice probabilities by MOS and TOS across simulated applicants.

(4) *Use the expected MOS-TOS accessions to estimate the total cost of the incentives by MOS and TOS.* Output from the JCM includes the number of applicants who are expected to take the EB, ACF, and/or LRP incentives by MOS and TOS. Using these estimates, the DST is able to compute the expected total cost for the EB, ACF, and LRP incentives for the full applicant sample and by MOS and TOS.

(5) *Compare estimated accessions obtained from an alternative policy against a baseline policy.* The DST includes a functionality for reporting the channeling effects of a given incentive

policy. This is reported in terms of the differences in estimated accessions and associated cost by MOS and TOS between a given incentive policy and a baseline policy.

Table 12. Levels and Minimum TOS by MOS in Q1 of FY 2010

MOS	Min. TOS	Level	MOS	Min. TOS	Level	MOS	Min. TOS	Level
09L	3	1	25S	4	1	88H	3	5
11X	3	3	25U	4	4	88L	4	5
12B	3	5	27D	4	3	88M	3	4
12C	3	5	31E	3	5	89A	4	5
12D	4	5	35F	3	5	89D	4	1
12Y	4	4	35G	3	5	91A	3	5
13B	3	5	35H	3	2	91C	3	5
13D	3	2	35M	3	5	91D	3	5
13F	3	3	35N	3	4	91J	3	5
13M	3	5	35S	3	4	91K	3	5
13P	3	3	35T	3	5	91L	3	5
13R	3	2	35W	5	1	91M	3	4
13S	3	4	42R9B	3	4	92F	3	4
13W	3	5	42R9C	3	5	92G	3	5
14E	3	4	42R9D	3	4	92L	3	5
14J	3	2	42R9E	3	5	92R	3	5
14S	3	5	42R9F	3	5	94A	3	2
14T	3	4	42R9G	3	5	94D	4	3
15B	6	5	42R9H	3	5	94E	4	3
15D	6	5	42R9J	3	3	94F	4	4
15G	6	5	42R9K	3	4	94H	5	5
15J	6	4	42R9L	3	5	94K	4	3
15N	6	5	42R9M	3	5	94L	6	5
15P	4	5	42R9N	3	3	94M	5	4
15Q	6	5	42R9T	3	4	94P	4	5
15S	6	5	42R9U	3	4	94R	4	5
15U	6	5	42S	3	5	94S	5	4
15W	4	4	45K	3	5	94T	4	5
15Y	6	5	46Q	5	2	94Y	3	4
18X	5	4	46R	5	2			
19K	3	4	52C	3	5			
21B	3	5	52D	3	5			
21C	3	5	56M	4	5			
21D	4	5	62B	3	5			
21K	4	5	63A	3	5			
21Y	4	4	63J	3	5			
25C	4	5	63M	3	4			
25F	4	3	68K	5	4			
25L	4	5	68Q	5	5			
25N	4	4	68S	4	5			
25P	4	1	68T	5	5			
25Q	3	2	68W	4	5			
25R	5	3	74D	3	5			

Figure 3. Defining Values of Incentive Levels in the DST

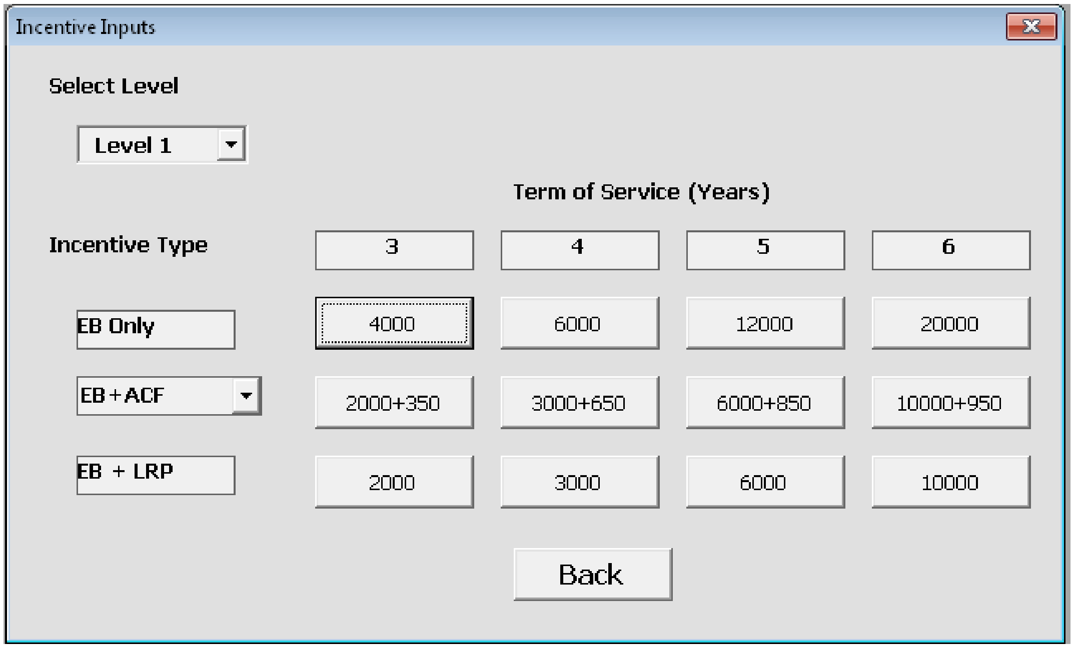
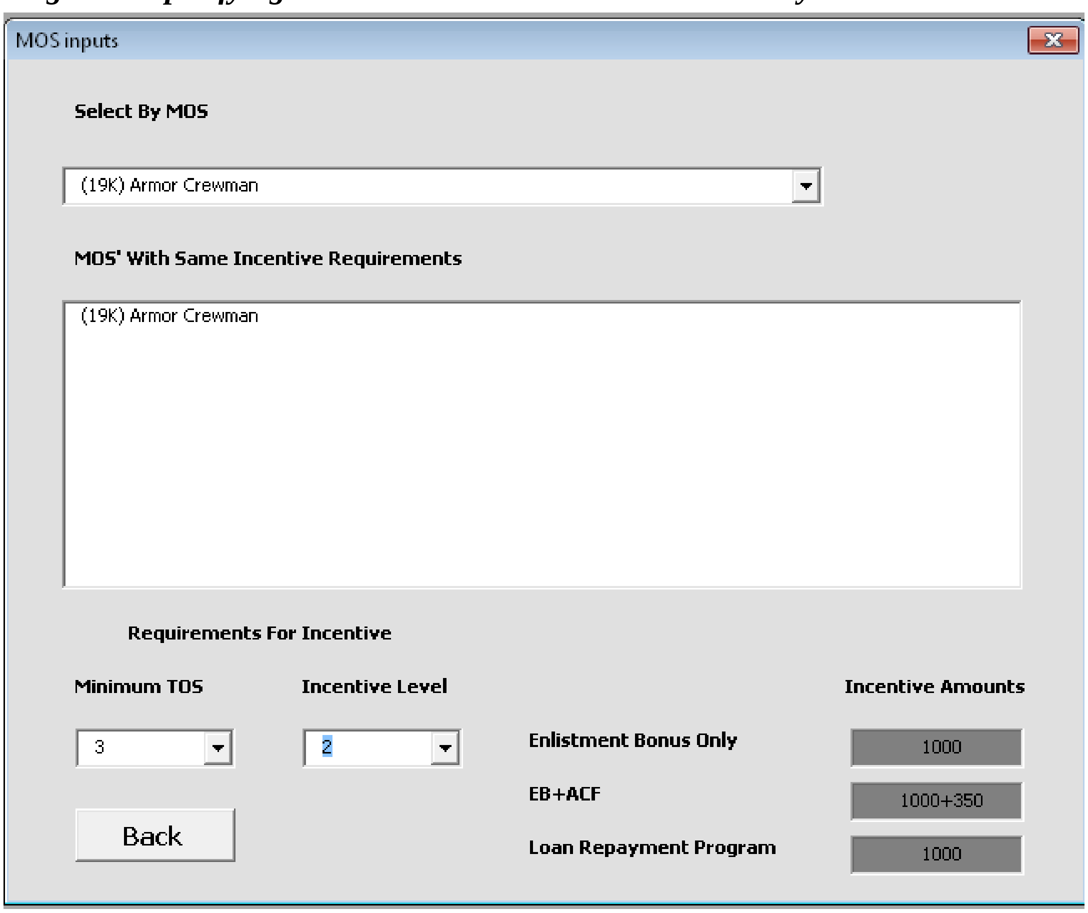


Figure 4. Specifying Incentive Levels and Minimum TOS by MOS in the DST



The current proof-of-concept version of the DST has the following limitations. First, the prediction period is limited to the quarter used in estimating the JCM (i.e., Q2 of FY 2010). To be useful for EIRB policy making, the tool must be able to carry out simulation analysis for future forecasting periods. Second, the tool presently sets incentives at the MOS cluster level. The EIRB user would need the flexibility to assign incentive levels separately for each MOS. Lastly, the tool uses a simple cost model for illustrative purposes.

Example 1: Changing Level of a Single MOS

The first example demonstrates the simple case for a single MOS. In this illustration, we raise the incentive level for 19K, from Level 4 offered in FY 2010 Q2 to Level 2, while the incentive levels for all other MOS are fixed at their level in FY 2010 Q2. (The EB/ACF dollar values by incentive level are shown in Table 6.) We compare the estimated accessions and estimated EB by MOS under this alternative policy to those obtained under the baseline policy corresponding to that in place in FY 2010 Q2. Figure 5 shows a screenshot of the comparison report generated by the DST. It shows the estimated accessions and EB dollars by MOS clusters/groups under each incentive policy, along with the differences in accessions and EB dollars between the two policies. Note that the MOS differences in this example are understandably small given that the alternative policy modified the incentive for a single MOS with a relatively small number of accessions.

Figure 5 shows that raising incentives from Level 4 to Level 2 is predicted to increase accessions for 19K by 62 individuals. To understand the nature of the channeling effect, we examine where these additional 62 accessions come from. Five of the 62 additional accessions for 19K are expected to come from applicants who previously did not sign a contract. That is, raising the incentive for 19K increased the total number of contracts. Of the remaining 57 additional accessions for 19K, 39 are expected to come from the 9,355 applicants who signed for combat jobs under the baseline policy (0.4% channeling effect), while 18 are expected to come from the 16,244 applicants who previously signed for other jobs (0.1% channeling effect). While small, these channeling effects are indicative of how changing the incentives for one MOS could affect the accessions for the other MOS. In this example, the additional accessions obtained by raising the incentive for 19K mostly come from other combat-related MOS. In other words, combat-related MOS are better substitutes for 19K than other MOS. Figure 5 also shows the effects in terms of EB dollars for the full applicant pool and by MOS. Raising the incentive for 19K from Level 4 to Level 2 is expected to increase the total cost of the EB incentive by over 2 million dollars. This amount is almost wholly accounted for by 19K.

This example demonstrates how the DST can assist in understanding the effects of raising the incentive level for one MOS only. Real world applications will likely involve raising or lowering the incentive for two or more MOS, with effects that are more difficult to anticipate. It is in such complex scenarios where the DST becomes very valuable. We also note that the proof-of-concept DST has more capabilities for presenting and organizing the results of incentive policy analyses.

Figure 5. DST Example Comparison Report

		9,517	9,512		-----	-----	
11X1	11B, 11C, 11X	5,441	5,420		$7,274	$7,226	
13F1	13F	509	507		$838	$832	
FA11	13D	335	333		$2,352	$2,336	
FA12	13B, 13M,	924	919		$0	$0	
FA21	13R	43	43		$82	$81	
FA22	13P, 13S,	98	97		$165	$163	
FA23	13T, 13W,	54	54		$0	$0	
AD11	14J	576	572		$7,994	$7,946	
AD12	14E, 14S, 14T	444	443		$332	$331	
AV11	15J	50	50		$0	$0	
AV12	15B, 15D, 15E, 15F, 15G, 15H, 15N, 15R, 15S, 15T, 15U, 15Y,	686	685		$0	$0	
AV21	15P, 15Q	49	49		$0	$0	
18X1	18X	318	316		$0	$0	
19D1	19D	613	612		$0	$0	
19K1	19K	364	426		$199	$2,420	
EN11	21Y	61	61		$98	$98	
EN12	12D, 12M, 12N, 12R, 12T, 12W, 21D, 21E, 21K, 21M, 21R, 21T, 21V, 21W, 91E, 91L, 91W	1,143	1,142		$0	$0	
EN21	21B, 21C,	798	797		$0	$0	
SI11	25R	21	21		$0	$0	
SI12	25B, 25M, 25V	172	171		$0	$0	
SI21	25P, 25S,	271	271		$3,727	$3,722	
SI22	25Q	896	895		$6,736	$6,726	
SI23	25F, 25N, 25U	444	443		$889	$887	
SI24	25C, 25L,	234	234		$0	$0	
LE11	31B, 31E,	443	443		$0	$0	
EL11	94A, 94D, 94E, 94F, 94M, 94S, 94Y	388	388		$790	$788	
EL12	68A, 91C, 94H, 94K, 94L, 94P, 94R, 94T	176	176		$99	$99	
EL21	35T	31	31		$0	$0	
AX11	27D	113	113		$199	$199	
AX12	56M	67	67		$36	$36	
AX13	36B, 42A, 42F	277	277		$0	$0	
AM11	91F, 91G, 91K	179	179		$0	$0	
52D1	91D	514	513		$337	$336	
VM11	91M	38	38		$0	$0	
VM12	91H, 91J, 91P	604	603		$0	$0	
VM21	91A, 91B,	936	934		$0	$0	
74D1	74D	270	269		$0	$0	
TR11	88H, 88K, 88L, 88N,	221	221		$0	$0	
88M1	88M	999	999		$367	$366	
89D1	89D	368	367		$5,024	$5,012	
89B1	89A, 89B,	168	168		$0	$0	
MD11	68K	38	38		$0	$0	
MD12	68D, 68E, 68G, 68H, 68J, 68M, 68P, 68Q, 68R, 68S, 68T, 68V, 68X	226	225		$0	$0	
MD13	68W	1,218	1,217		$0	$0	
92F1	92F	459	459		$165	$165	
92G1	92G, 92R,	763	762		$0	$0	
SL11	92A, 92L, 92M, 92S, 92W, 92Y,	1,559	1,558		$0	$0	
IN11	35W	257	257		$2,127	$2,124	
IN12	35H	41	41		$85	$85	
IN13	35N	210	209		$198	$197	
IN14	35F, 35G, 35S	583	582		$0	$0	
HI11	35M	246	246		$0	$0	
15W1	15W	27	27		$0	$0	

Example 2: Varying EB/ACF/LRP Policy Levels

In the second example we modify incentive level definitions while keeping the levels assigned to MOS the same as those prevailing in the FY 2010 Q2 incentive policy. For this illustration we look at how changes in incentive definitions affect accessions by TOS. As in the first example, the baseline corresponds to the FY 2010 Q2 incentive policy. The types of incentives offered at each incentive level are shown in Table 13 under the column labeled "Baseline." For levels 1 and 2, three types of incentives are available, namely, full cash bonus (EB), reduced bonus with ACF (EB+ACF), or reduced bonus with LRP (EB+LRP). For levels 3 and 4, full cash bonus is available but a reduced bonus is not offered in combination with ACF or LRP. For level 5, only ACF or LRP are available. The dollar EB/ACF amounts by level were shown earlier in Table 6. The first alternative policy, labeled "Option 1" in Table 13, eliminates ACF from levels 3 to 5. The second alternative policy, labeled "Option 2", further eliminates the reduced bonus with ACF from levels 1 and 2. The last alternative policy, labeled "Option 3", eliminates all EB and ACF incentives.

Table 14 summarizes the accessions by TOS from the four policy simulations. The proof-of-concept version of the DST does not generate comparisons by TOS across several policy options, but the necessary values are readily available from individual policy simulation reports. Under the baseline policy, we would expect 85% of applicants to sign for either 3-year or 4-year terms, with the remaining 15% signing up for a 5-year or 6-year term. By eliminating ACF from levels 3 – 5 under Option 1, the shorter term contracts dropped from 85% to 78%, while longer term contracts increased from 15% to 22%. Overall, total contracts dropped about 3.6%, from 25,964 to 25,028. Note that the increase in longer term contracts represents a gain of over 40%. Further eliminating ACF from levels 1 and 2 under Option 2 slightly increased longer term contracts from 22% to 23%, with minimal change in total contracts. Lastly, eliminating all EB and ACF incentives from levels 1 to 5 under Option 3 produced about the same distribution of shorter term and longer term contracts as the baseline policy, but with 5.6% fewer total contracts (dropping from 25,964 in the baseline policy to 24,522 in Option 3). Also, note the relatively substantial drop in expected 6-year contracts, from 9% in the baseline policy to 7% in Option 3.

The above findings regarding the channeling effects of changing the availability of the ACF are consistent with earlier interpretations of the JCM parameters, which suggested that the ACF component in the reduced EB+ACF incentive package has relatively more value to applicants at shorter terms of service. Eliminating ACF under Options 1 and 2 from the baseline policy made the 3-year and 4-year terms less attractive, effectively channeling applicants from shorter to longer TOS. While the channeling effects observed in the two illustrative examples are intuitive and can be anticipated, the benefit of the JCM and DST is that these effects can be measured. This benefit becomes more important in real world policy decisions of the EIRB, which often involve moving two or more MOS to different incentive levels while at the same time modifying the EB/ACF dollar values of incentive levels.

Table 13. Example Alternative Policy Definitions

Level	Baseline	Option 1	Option 2	Option 3
1	EB, EB+ACF, EB+LRP	EB, EB+ACF, EB+LRP	EB, LRP	LRP
2	EB, EB+ACF, EB+LRP	EB, EB+ACF, EB+LRP	EB, LRP	LRP
3	EB, ACF, LRP	EB, LRP	EB, LRP	LRP
4	EB, ACF, LRP	EB, LRP	EB, LRP	LRP
5	ACF, LRP	LRP	LRP	LRP

Table 14. Example Alternative Policy Simulation Results by TOS

	Baseline		Option 1		Option 2		Option 3	
TOS	**N**	**Pct**	**N**	**Pct**	**N**	**Pct**	**N**	**Pct**
3	14,491	55.8%	12,848	51.3%	12,565	50.5%	13,746	56.1%
4	7,444	28.7%	6,722	26.9%	6,580	26.5%	7,192	29.3%
5	1,633	6.3%	2,165	8.7%	2,249	9.0%	1,840	7.5%
6	2,395	9.2%	3,293	13.2%	3,481	14.0%	1,745	7.1%
Total	25,964	100.0%	25,028	100.0%	24,875	100.0%	24,522	100.0%

Discussion and Recommendations

Our review of the EIRB process indicates that it focuses primarily on characterizing the magnitude of recruiting shortfalls by MOS. For example, the USAREC MOS Ranking Model and AMB Recruiting Priority Model, which are used as aids during EIRB deliberation, both compute priority scores as linear combinations of several factors, including MOS fills, targets, and criticality. To complement these models, a tool is needed that the EIRB can use to assess the effectiveness of incentives to achieve enlistment goals and reduce shortfalls, allocate incentives efficiently and effectively, and help understand how incentives affect applicant preferences. In this project, we developed a proof-of-concept DST that can help the EIRB achieve these objectives.

At the core of the proof-of-concept DST is a JCM that represents applicant (MOS, TOS) enlistment choices as a function of incentives associated with enlistment alternatives, applicant test scores and demographics, and MOS characteristics. We specified a JCM based on a mixed multinomial logit model which related unobserved applicant characteristics to similarities among groups of MOS to provide realistic channeling effects or substitution patterns. (For instance, combat jobs are better substitutes for each other than for clerical jobs.) The JCM developed in this research was based on the model previously estimated to analyze the impact of increasing the bonus cap to $40K on MOS-TOS enlistment choices of applicants. We improved the previous model so that it can be used to evaluate specific incentive configurations, not just the overall total incentive value. Using the improved specification, the effect of the full bonus and reduced bonus incentive packages on applicant choices can be directly measured. We estimated the JCM using actual applicant choice data from the first and second quarters of FY 2010. Overall, the estimated JCM fits the data well, with a pseudo R-squared (0.28) that is reasonably good given the dimension of the choice space and estimated parameters that were shown to be very meaningful behaviorally. Using a separate hold-out sample from the same period, we also validated the internal predictive accuracy of the estimated JCM.

Using an MS Excel interface, we developed a proof-of-concept DST that allows users to construct incentive policy scenarios as they appear in MILPER messages, by specifying the dollar values for each incentive level, the level for each MOS, and the minimum TOS for an MOS to be eligible for an incentive. Under the hood, the DST generates applicant transaction data with incentives based on the specified policy scenario. It then predicts the number of enlistments by MOS, TOS, and type of incentives using simulations based on the estimated JCM. By running different policy scenarios, the user will be able to evaluate different incentive configurations in terms of overall enlistment goals and total costs or examine their impact on specific MOS. The proof-of-concept DST includes the capability to compare enlistments by MOS for any two policy scenarios. Additional customized comparisons can be added in future versions of the tool, based on needs of the EIRB.

We demonstrated how the DST could assist the EIRB using two examples. In the first example, we raised the incentive level for MOS 19K while holding the levels for all other MOS fixed. This simple example demonstrated channeling effects using an easy to follow scenario. The real world application will likely involve raising or lowering the incentive level for two or more MOS. The DST will be very valuable in this more complex situation where the effects would be difficult to anticipate. In the second example, we created policy scenarios by modifying types of incentives (i.e., EB, ACF, or LRP) available for each level. This scenario essentially changed the relative values of incentives offered by MOS even if the levels assigned to MOS were fixed. For a more general version of this example, the value of the incentive levels can be fine-tuned by modifying the amounts of the full or reduced bonus without changing the structure of the incentive levels. In general, the flexibility of the DST can assist in making policy decisions in fast changing scenarios.

The proof-of-concept DST is currently limited to predict enlistments for the period used to estimate the JCM. While it can be used to inform future EIRB incentive policies in times when enlistment goals are similar to those in the first and second quarters of FY 2010, a more general forecasting capability is needed. The root of this limitation is the JCM's choice set, which is based on the REQUEST job list. This job list is often a product of one or more sub-queries based on applicant preferences (e.g., career field). In the extreme case, the list is reduced to a single MOS along with the option of not joining the Army. This means that the final job list produced by REQUEST already reflects applicant preferences, which presumably are affected by enlistment incentives in place during the estimation period and the needs of the Army during the same period. Therefore, the DST will be handicapped in two ways if the same REQUEST data are used in forecasting. First, applicant preferences partially reflected in the job list will be carried over to future forecasting periods, even if there are big changes in future incentives or the Army's needs. Second, because these partial applicant preferences were conditioned out during estimation, the JCM will not be able to fully characterize applicant preferences in future periods, even if expanded job lists (without applicant preference filters) are utilized.

The key to correcting the above limitation is to untangle partial applicant preferences in the job list during estimation and forecasting. We considered analytic approaches (e.g., reweighting the enlistment alternatives in the REQUEST job list) for accomplishing this, but they require another layer of models and assumptions. An approach that directly uses training requirements and seats information would be more practical. For estimation, one approach would be to expand the job list obtained from REQUEST with a best estimate of the longer list before preference-related filters were applied using training seats information. The JCM would then be estimated using this expanded choice set. For forecasting, a general approach would be to construct the job list based on training requirements and seats, combined with policy based rules (e.g., aptitude area cut scores) and management controls (e.g., Delayed Entry Program policy).

Additional limitations to the proof-of-concept DST are less complicated to resolve. Presently the tool can only assign incentive levels to groups or clusters of related MOS. While these clusters were constructed such that the incentive levels of MOS within a group are approximately the same during the estimation period, this constraint cannot be guaranteed in future forecasting periods. The DST can be reprogrammed to directly assign incentive levels to MOS and to implement a randomization or averaging rule, using incentive levels to weight MOS in a cluster, for determining how to represent the cluster in forecasting applications. Another limitation is that the DST presently lacks the capability to modify the applicant supply to reflect future changes in recruiting conditions. One way to build this capability is to add a weighting mechanism in the DST for expanding or contracting specific applicant demographic subgroups. Another limitation relates to the cost analysis and reporting functions of the DST. This can be expanded using a more detailed and realistic cost model. Lastly, to improve the tool's usability, the simulation-based computations need to be implemented more efficiently. This can be accomplished by writing a JCM program that is customized for the EIRB application and closely integrated to the user interface and reporting components of the DST.

In sum, the estimated JCM was demonstrated to meaningfully characterize the effects of incentives on applicant enlistment choices. For simple policy changes the effects were intuitive, while for complex policy changes the effects were more difficult to anticipate. In both cases, the benefit of using the JCM is that the effects of policy changes on MOS fills and budget can be measured or quantified objectively. A DST that implements such a JCM can be a very valuable tool for informing the EIRB in the allocation of incentives to MOS and TOS enlistment options in order to provide the most benefit to the Army.

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